CALIFORNIA
ENERGY
COMMISSION

TRANSPORTATION FUELS, TECHNOLOGIES, AND INFRASTRUCTURE ASSESSMENT REPORT

DRAFT STAFF REPORT

Prepared in support of the Integrated Energy Policy Report Proceeding, (02-IEP-01)

JULY 2003
100-03-013 D

Gray Davis,
Governor

CALIFORNIA ENERGY COMMISSION

Charles Mizutani,
Principal Author

Bill Blackburn,
Sue Kateley,
Contributing Authors

Charles Mizutani,
Project Manager

Lila Watson,
Project Secretary

Scott W. Matthews,
Deputy Director
Transportation Energy Division

Karen Griffin,
Program Manager
Integrated Energy Policy Report

Robert L. Therkelsen,
Executive Director

ACKNOWLEDGEMENTS

This report was prepared with the contributions from the following:

Brian Covi
Dan Fong
Chris Kavalec
Tom MacDonald
Daryl Metz
Michael Nyberg
Jim Page
Pat Perez
Jeff Poteet
Gordon Schremp
Leigh Stamets

Table of Contents

EXECUTIVE SUMMARY

California's gasoline and diesel fuel demand is outpacing its in-state production capacity. If current consumption trends continue, California's transportation fuel supply industry will need to increase its current in-state production and imports and improve its infrastructure to accommodate greater levels of imported gasoline and diesel fuel. In responding to this and other issues, the Legislature passed Senate Bill 1389 (Chapter 568, Statutes of 2002; Bowen), which requires the California Energy Commission (Energy Commission) to identify emerging transportation energy trends and potential adverse social, economic or environmental impacts.

The legislature also directed the Energy Commission to assess and recommend administrative and legislative actions for the transportation, electricity and natural gas energy sectors. This report addresses the trends, issues and recommendations for the transportation energy sector.

The Energy Commission staff analyzed California's highway vehicles and aviation transportation energy sector and identified actions to increase gasoline and diesel supply imports to meet the growing demand for transportation fuels. Efficiency measures are cost-effective options that can be implemented immediately on existing vehicles and higher fuel economy can be implemented on new vehicles over the next fifteen years to reduce the magnitude of future supply increases needed to meet growing fuel demand. In the longer-term, industry will need to respond to emerging economic and environmental factors and transition to non-petroleum energy resources to provide adequate, secure and cost-effective transportation fuels for California.

CALIFORNIA'S TRANSPORTATION FUEL MARKET

As California's future population and economic output grow, demand for transportation services and fuels will grow. The Energy Commission has forecasted that total gasoline and diesel use will increase by almost 35 percent over the next 20 years. Only incremental supply increases can be realized through technological and process improvements of in-state refining production. These improvements will not be able to keep pace with the rate of future demand growth.

The state can improve the flow of gasoline and diesel fuel into the state by improving the permitting process and reducing marine infrastructure bottlenecks, thereby relieving our current situation of continued supply disruptions and price spikes.

However, the industry will need to greatly increase its importation of gasoline and diesel fuel to meet demand growth. At this time, there has been a paucity of information and activity to indicate that the transportation fuel industry is planning or can meet California's transportation fuel demand growth. Without increasing the fuel supply to import additional gasoline and diesel fuel supply, California will not only continue to experience supply disruptions and price spikes, but also supply shortages and prolonged and elevated prices, for both gasoline and diesel fuels.

California will experience even greater economic and environmental burdens, in the long term, if it continues to rely exclusively on its current transportation energy supplies and does not develop other energy resource options.

Historically, California has obtained supplies of crude oil from in-state production, imports from Alaska and imports from foreign sources. In-state and Alaskan supplies has and will continue to be in decline. This has resulted in California's growing reliance on foreign imports to meet its transportation fuel needs. As the state begins to rely more exclusively on imports of crude oil for transportation energy, the status of world oil resources and production rates becomes increasingly important. Similar to the crude oil resources in Alaska and California, foreign sources of imports will also reach a peak in production before declining. Experts, at this time, continue to debate the timeframe that production of world petroleum resources will peak based on known and available data. Some experts believe the petroleum production peak will occur in the next 10 to 20 years. Other experts and the oil industry maintain technological improvements to extract petroleum, economics and additional discoveries will extend the production peak well into the next century.

The combustion of fossil fuels produces carbon dioxide and other greenhouse gas emissions. Greenhouse gas emissions from human activities are causing changes in the earth's atmosphere, which have resulted in significant economic, environmental, and ecological impacts. As the effects of climate change intensify, transportation fuel options will need to focus on efficiency improvements and fuels and energy sources with potential for lower greenhouse gas emissions.

If California is to have a market that can provide adequate, secure, and cost-effective transportation fuels, it must begin to transition from petroleum as its predominant source of energy to other sources, as well as decrease demand for transportation fuels by developing more efficient means of using those fuels.

IMPROVING THE STATE'S SUPPLY–DEMAND IMBALANCE

To meet California's transportation energy needs, in the near-term, petroleum will be the energy resource of choice. The gap between in-state gasoline and diesel production and fuel demand will be filled by importing additional gasoline and diesel. Marine terminal, distribution, and storage capacities need to be increased to ensure that unconstrained movement of imported gasoline and diesel supplies are adequate to meet the state's near-term transportation fuel demands.

Future gasoline and diesel supplies will be imported through California's marine infrastructure by tanker ship at the state's port facilities. California's marine infrastructure to accommodate imports of gasoline and diesel supply is at or near capacity. Without further expansion of the marine infrastructure to receive, store and distribute gasoline and diesel fuels, supply disruption and price volatility will continue to be an issue for the California motorists.

Ensuring an adequate fuel infrastructure can mitigate current price volatility, but is not sufficient to address continued transportation fuel demand growth. Increasing imports of gasoline and diesel, well over current importation levels, will be necessary to meet near-term demand growth, which is expected to increase by over 13 percent over the next five years from 18 billion gallons to 20.3 billion gallons.

Over the next five to fifteen years, measures that improve vehicle fuel efficiency can lessen and mitigate the growing demand for transportation fuel. By reducing the rate of transportation fuel demand growth, the need to increase production and importation of gasoline and diesel will be lessened.

In the longer-term, the state needs to transition from its reliance on conventional petroleum resources to a transportation fuel system that uses gasoline and diesel more efficiently along with fuels that have lower life cycle greenhouse gas emissions. The Energy Commission and Air Resources Board have adopted a policy goal of reducing gasoline and diesel fuel demand to 15 percent below 2003 demand levels by 2020 and to maintain that level for the foreseeable future.

To achieve this policy goal, the state's policy strategy must rely on economically feasible options that reduce petroleum usage and provide net societal benefits. The Energy Commission and California Air Resources Board laid out a strategy, which had a timing hierarchy, of petroleum reduction options. The transition strategy would begin with petroleum reduction options that would reduce gasoline and diesel demand growth where overall gasoline and diesel fuel demand would peak by 2010. Deployment of additional options would result in a 2020 demand level that was 15 percent below 2003 levels. Finally, other options would be implemented to maintain future gasoline and diesel demand at 15 percent below 2003 levels beyond 2020.

Between now and 2010, promising options include vehicle efficiency improvements for conventional vehicle technology.

In the 2010 to 2020 timeframe, additional promising options include doubling of California's new light-duty vehicle fleet fuel economy to 40 miles per gallon and increasing the use of non-petroleum fuels, such as natural gas-derived Fischer-Tropsch fuel as a 33 percent blending agent in diesel.

Between 2020 and 2030, further options include additional non-petroleum fuel vehicle technology, along with the deployment of related fueling infrastructure, such as natural gas, ethanol, electricity and hydrogen.

Beyond the 2030 timeframe, greater penetration of sustainable, non-petroleum fuel such as hydrogen will be needed to maintain the long-term effectiveness of a petroleum reduction strategy.

STAFF RECOMMENDATIONS

To avoid the adverse consequences of the energy issues confronting California currently, as well as in the longer-term, and be able to provide Californians with adequate, secure and cost-effective transportation fuels, the Energy Commission staff recommends the following actions be pursued:

For the Near Term

1. The Energy Commission will undertake a comprehensive evaluation of California's infrastructure needed to handle future crude oil petroleum product imports, in consultation with the following agencies – State Lands Commission, Ports of Los Angeles and Long Beach, Coastal Commission, and San Francisco Bay Conservation and Development Commission.

2. The Governor and Legislature should identify a state licensing authority for petroleum infrastructure facilities.

3. California should continue to pursue a California waiver from U.S. EPA's oxygenate requirements.

4. The Energy Commission should continue to monitor the enactment and implementation of the pending federal Energy Policy Act legislation and its impact on California's transportation fuel price and supply.

5. The Energy Commission should continue to monitor the progress of refineries to meet the CARB low sulfur diesel fuel regulation, as well as the progress of other states' implementation efforts.

6. The Energy Commission should work with the transportation fuel industry to collect information on future expansion and construction plans for in-state refining capacity, importation of crude oil, blend stocks and finished products to assess future supply adequacy as well as constraints to expansion and construction that might adversely impact the delivery of future transportation supplies.

For the Longer Term

1. The Governor and Legislature should adopt the recommended statewide goal of reducing demand for on-road gasoline and diesel to 15 percent below the 2003 demand level by 2020 and maintain that level for the foreseeable future.

2. The Governor and Legislature should work with the California delegation and other states to establish national fuel economy standards that double the fuel efficiency of new cars, light trucks, and sport utility vehicles (SUVs).

3. The Governor and Legislature should establish a goal to increase the use of non-petroleum fuels to 20 percent of on-road fuel consumption by 2020 and 30 percent by 2030.

4. The Energy Commission should establish a working group of industry, environmental, and academic stakeholders to develop specific strategies to support research, development, and demonstration consistent with the recommendations adopted in ***Reducing California's Petroleum Dependence*** which was in response to the mandates in AB 2076 (Chapter 936, Statutes of 2000; Shelley).[1]

5. The Energy Commission should continue to analyze the strategies identified in the AB 2076 report to improve its understanding of the costs and effectiveness of new vehicle technologies, the value to the state of reduced environmental damages, the impact of higher fuel efficiency on vehicle safety, consumer choices, and driving patterns.

6. The Energy Commission staff should expand its analytical capability to evaluate the costs and benefits of fuel demand reduction options and deployment schemes, including: land use planning concepts, public transportation, and voluntary accelerated vehicle retirement.

7. The Energy Commission, through public/private partnership collaboration, should pursue basic transportation energy research, hardware development, and infrastructure deployment.

8. The Energy Commission should monitor world oil supply market to provide as much advance planning opportunity to respond to significant changes in the world oil production. Monitoring areas include: production profiles, especially for countries that may be nearing their production peaks, reserves to production ratios, industry and related financial markets, global oil substitution and demand reducing trends, and OPEC market share trends.

CHAPTER 1: INTRODUCTION

Establishing energy policy for the State of California is the basis for the development of the ***Integrated Energy Policy Report***. Senate Bill 1389 (Chapter 568, Statutes of 2000; Bowen) requires the California Energy Commission (Energy Commission) to identify emerging energy trends, potential adverse social, economic and environmental impacts, and assess and recommend administrative and legislative actions for the transportation, electricity and natural gas energy sectors. This report addresses the trends, issues and recommendations for on-road gasoline and diesel use in the transportation sector.

Mobility is a public good that provides economic benefits to California. The ability to move people, goods and services efficiently and cheaply has been able to support the state's competitiveness as the fifth largest economy in the world. Industry and the public sector have developed technologies, infrastructure and fuels to meet Californians' transportation needs. A critical component of mobility has been the availability of those fuels used to move the vehicles that transport the goods and people. Mobility, while providing economic benefits, has also created resource challenges in the form of dependence on a finite resource, petroleum, and environmental damages in the form of air, water and waste pollution. While ensuring adequate and reliable transportation energy to Californians is the state's primary energy goal, protecting public health and the environment remain important objectives that need to be considered in developing energy policies that improve and protect access and use of transportation energy for Californians.

Public Resources Code (PRC) Section 25304 directs the Energy Commission to conduct transportation forecasting and assessment activities, including:

1. Transportation fuels, technologies and infrastructure trends.

2. Transportation energy demand forecast.

3. Sufficiency of transportation fuel supplies.

4. Risks of supply disruptions, price shocks or other events and their consequences on transportation fuels and the state's economy.

5. Potential for needed changes to maintain sufficient, secure and affordable transportation supplies.

6. Alternative transportation energy scenarios to examine potential effects on public health and safety, the economy, resources, the environment and energy security.

7. Status of advanced transportation technologies and clean-burning transportation fuels.

8. Recommended actions to improve efficiency of transportation energy use, reduce petroleum fuels dependence, decrease environmental impacts, contribute to reducing

congestion, promoting economic development, enhancing energy diversity and security, and advance public interest energy strategies for transportation.

This ***Staff Draft Transportation Fuels, Technologies, and Infrastructure Assessments Report*** provides the information and analysis for the forecasting and assessment activities identified under PRC Section 25304, as part of the Senate Bill 1389 energy policy requirements for the Energy Commission. The report is organized to follow the sequence of forecasting transportation energy demand; evaluating the sufficiency of transportation energy supplies; identifying issues and barriers that prevent supply and demand balance; assessing the issues and barriers; and developing findings and recommendations to overcome or mitigate the issues and barriers.

A general summary of the individual chapters follows.

Chapter 2: Twenty-year forecasts of transportation fuels are developed and the factors that most affect continued growth of energy demand for transportation fuels are identified.

Chapter 3: Future supply trends based on current production capability are developed and California's fuel supply status is presented.

Chapter 4: Issue areas that create and exacerbate the growing supply and demand imbalance are identified and discussed.

Chapter 5: Analysis, findings and conclusions are developed to mitigate current and future price shocks.

Chapter 6: Analysis, findings and conclusions are developed to address the current issue of gasoline and diesel supply sufficiency.

Chapter 7: Analysis, findings and conclusions are developed to address the issue of growing reliance on imported petroleum by developing and implementing a portfolio of energy efficiency and non-petroleum fuel options to displace petroleum fuels.

Chapter 8: Recommended options to improve California's transportation energy system are identified.

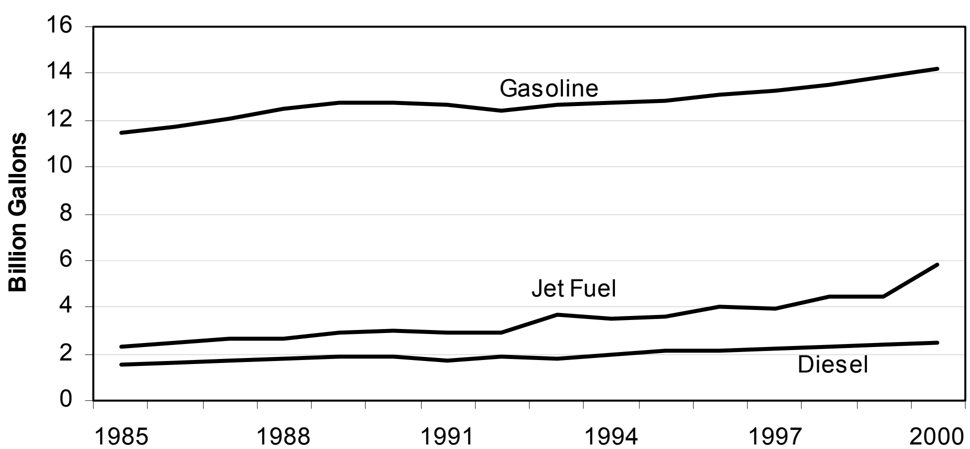
CHAPTER 2: TRANSPORTATION ENERGY DEMAND

California's demand for transportation fuels continues to increase as its population and economy grow. Motor vehicles will continue to be the most economical and convenient mode to transport goods, services and people for the foreseeable future.

CURRENT TRENDS

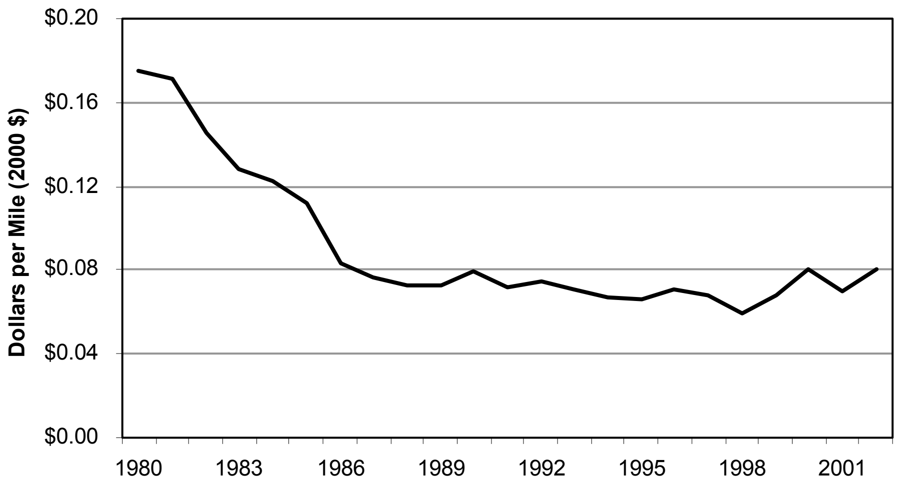
Beginning in the 1980s, California's population grew an average of 1.9 percent per year and the number of on-road vehicles grew at nearly the same rate. Due in part to rising, real per-capita income, total on-road travel in the state increased at a significantly higher rate—an average of 3.3 percent annually. During the same period, gasoline and diesel demand increased by an average of 1.8 percent. **Figure 2-1** shows historical gasoline, diesel and jet fuel demand in California. The decline in petroleum demand during the late 1980s and early 1990s and the resumption of demand growth in the middle 1990s are indicative of the way economic activity affects transportation demand; these patterns closely follow California's economic conditions in the post Cold War era.

Figure 2-1
Historical California Demand for Gasoline, Diesel and Jet Fuel



Travel increased at almost twice the rate of population growth. Since 1980, the real cost of gasoline has dropped by 40 percent while fleet-average fuel economy has nearly doubled.[2] As a result, the average per-mile cost of gasoline is less than one-half of what it was in 1980. **Figure 2-2** shows the average per mile cost (in 2000 dollars) of operating a gasoline-powered light-duty vehicle (LDV) over the period from 1980 to 2002.

Figure 2-2
Average per Mile Cost of Gasoline, 1980-2002



For 2002, the average California household vehicle miles traveled (VMT) was 20, 049 miles. Per household, gasoline purchases averaged 954 gallons in 2002. For the same period, VMT per business establishment averaged 66, 929 and gasoline use per business establishment averaged 2,419 gallons. During this period the price for gasoline and diesel averaged $1.47 and $1.48 per gallon respectively. Out-of-pocket gasoline cost per household was $1,400 per year and business was roughly $3,600 per year.[3]

Table 2-1 shows that gasoline demand exceeds all other types of fuel demand. Gasoline demand is three times greater than jet fuel. Distillate, primarily diesel, is used for both on-road and off-road vehicles. On-road vehicles use about 90 percent, and railroad applications use another eight percent of the distillate consumed in California.[4]

Table 2-1:
California Petroleum Demand in the Transportation Sector—2000

Fuel Type	Percent	Thousand Barrels per Day
Motor Gasoline	61.1%	933
Jet Fuel	18.4%	282
Distillate	12.5%	191
Residual	7.3%	112
Other	0.7%	11
Total	100.0%	1,529

LDVs include automobiles, pickup trucks, vans, and sport utility vehicles (SUVs). The latter three vehicle categories are termed "light truck," and collectively comprise 41 percent of LDVs. LDVs account for nearly all of California's on-road passenger movement. In 2002, Californians registered about 24 million gasoline-powered vehicles. Small fleets of liquefied petroleum gas, natural gas, alcohol, and electric vehicles, cumulatively totaling about 120,000 (or approximately six-tenths of 1 percent of the vehicle population), also operate in California. In 2001, Californians purchased 1,078,000 new cars and 971,000 new light trucks. Commercial fleet vehicles account for about one-third of these purchases.

The average fuel economy of gasoline-powered LDVs has steadily increased since the mid-seventies from 12.6 miles per gallon to today's 20.6 miles per gallon. However, consumers' growing preference for light trucks, particularly minivans and SUVs with lower average fuel economy, has caused fleet-average fuel economy to level off for the first time since 1973.

Heavy-duty vehicles (HDVs) include medium and heavy-duty trucks and buses. Most HDVs provide on-road freight movement. A much smaller number account for passenger transport. There are about 867,000 HDVs registered in California (HDVs are generally defined as those vehicles that weigh over 10,000 pounds), which use approximately 2.6 billion gallons of diesel and 7 million gallons of gasoline annually.

FORECAST

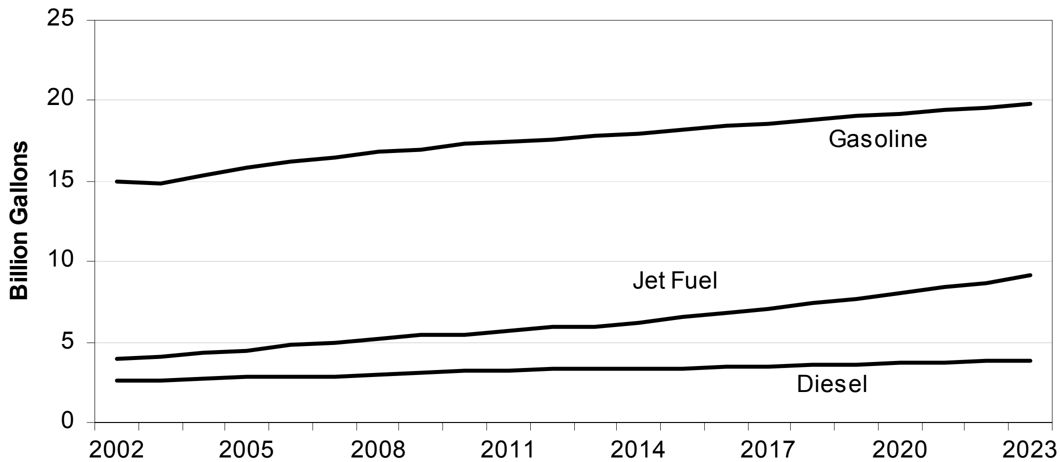
Figure 2-3 shows the Energy Commission's base-case forecast for on-road gasoline, on-road diesel, and jet fuel demand. The forecast projects on-road gasoline demand to increase from 15.0 billion gallons in 2002 to 17.3 billion gallons in 2010 and to 19.8 billion gallons by 2023. Jet fuel demand is projected to increase from 4.1 billion gallons in 2002 to 5.6 billion gallons in 2010 and to 9.1 billion gallons by 2023. Diesel demand is projected to increase from 2.6 billion gallons in 2002 to 3.2 billion gallons in 2010 and to 3.9 billion gallons by 2023. These forecasts translate to an average increase of about 1.4 percent per year for gasoline, 4.0 percent annually for jet fuel and about 1.9 percent for diesel.

The forecast of jet fuel demand is based on projecting growth of commercial aviation passenger volume in California from 159 million in 2000 to 366 million in 2023. Although commercial aviation travel in California declined about 10 percent between 2000 and 2002, staff assumed that airline travel will resume historical growth rates beginning in 2003.[5] Base-case projections for electricity and compressed natural gas (CNG) demand include transit as well as light-duty applications.

By 2023, the Energy Commission projects that the number of on-road vehicles will reach over 33 million in California, up from about 24.4 million in 2002 (of which over 97 percent are LDVs), an average growth rate of 1.5 percent per year. Primarily due to the continued growth in the smaller sport and cross utility vehicles, the forecast projects that light trucks will continue to increase as a fraction of LDV stock in California, making up over 44 percent by 2023, up from 41 percent in 2002. The base case assumes slight fuel economy growth in conventional gasoline vehicles after 2008, significant penetration levels projected for electric hybrids, and increased availability of light-duty diesels.

These assumptions yield a forecast that shows LDV fleet-average fuel economy increasing by 2.4 percent over the forecast period, from 20.6 miles per gallon (mpg) in 2002 to 21.1 mpg in 2020. Fuel efficiency for gasoline LDVs is projected to decline slightly until model year 2007 or 2008, reflecting recent trends, and then begin to increase. As an example, compact car mpg declines from 26.0 to 25.9 between 2003 and 2008, and then reaches 26.3 mpg by 2020.

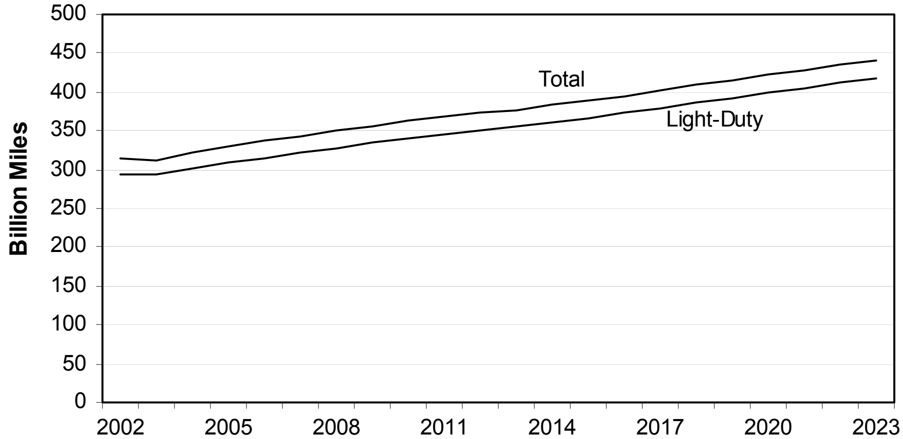
Figure 2-3
California Demand for Gasoline, Diesel and Jet Fuel Forecast



The Energy Commission's base-case forecast assumes gasoline prices of $1.68 per gallon (in 2003 dollars) beginning in 2004. The price for on-road diesel is projected to be $1.63 in 2004 and 2005, and $1.67 from 2006 onward. These projections are based on long-term world crude oil prices averaging $25.00[6] per barrel. In addition, the Energy Commission assumes that smaller sport and cross utility vehicles will continue to increase as a percentage of new LDV sales through 2010.

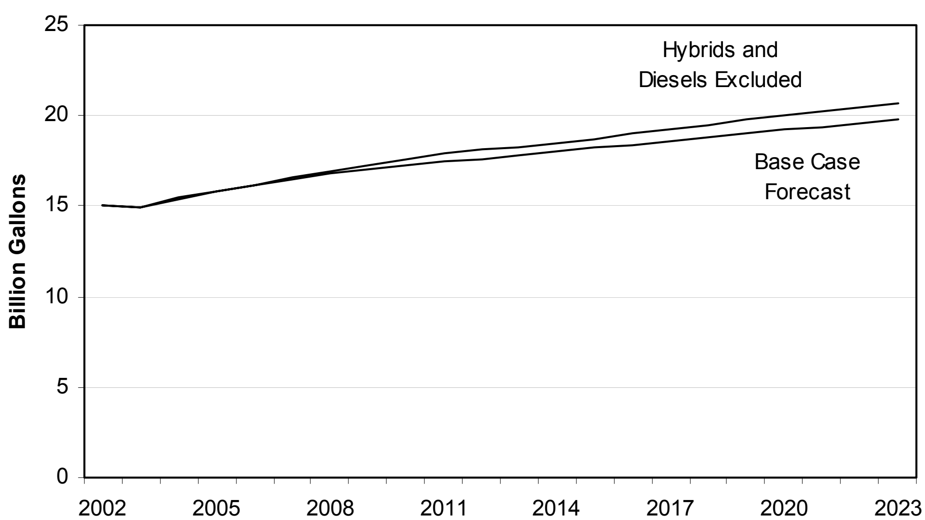
Figure 2-4 shows the projected trend in VMT for LDVs and all uses combined. The Energy Commission projects that on-road VMT (LDVs, freight, and transit) will increase in California from 313 billion miles in 2002 to 362 billion miles in 2010 to over 440 billion by 2023. This represents an average increase of 1.7 percent per year over the forecast period. Light-duty vehicle VMT, which makes up about 95 percent of the total, is expected to increase from 294 to almost 420 billion miles over the forecast period, a rate of 1.7 percent per year.

Figure 2-4
Forecast On-road VMT 2003-2023



Electric hybrid vehicles sales are projected to increase from 5,300 in 2002 to 144,000 in 2010 and to 259,000 by 2020 (about nine percent of total sales in 2020). For light-duty diesels, sales are projected to reach 56,000 in 2010 and 70,000 by 2023. The fleet penetration of hybrids and diesels serves to reduce LDV gasoline demand projections by almost one billion gallons per year by the end of the forecast period as shown in **Figure 2-5**. Without increased market penetration of hybrids and light-duty diesels, the projected growth rate for gasoline demand from 2003-2023 would average 1.6 percent per year.

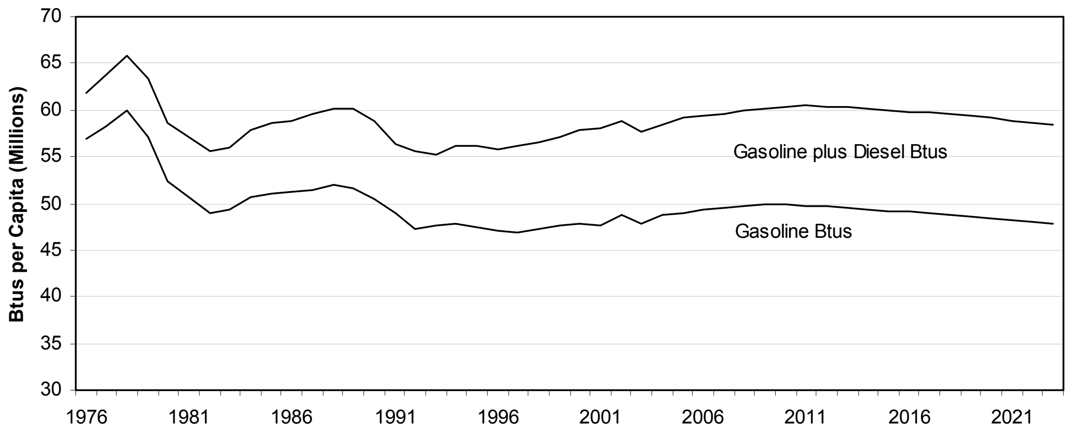
Figure 2-5
Impact of Hybrid and Electric Vehicles on Projected Demand



Demand for electricity in the transportation sector is expected to grow from 660 to 2,000 million kilowatt-hours between 2002 and 2023. During the same period, demand for natural gas in on-road vehicles will increase from 62 to 250 million therms.

Overall, California has had improvements in vehicle efficiency, mostly as a result of vehicle fuel efficiency standards (CAFÉ). **Figure 2-6** shows the historical and projected trends in fuel consumption per capita in California. The trend toward improvements in efficiency in the future will only be realized if the assumptions regarding future efficiency and technologies occur.

Figure 2-6
California Historical and Projected Btus per Capita, 1976-2023



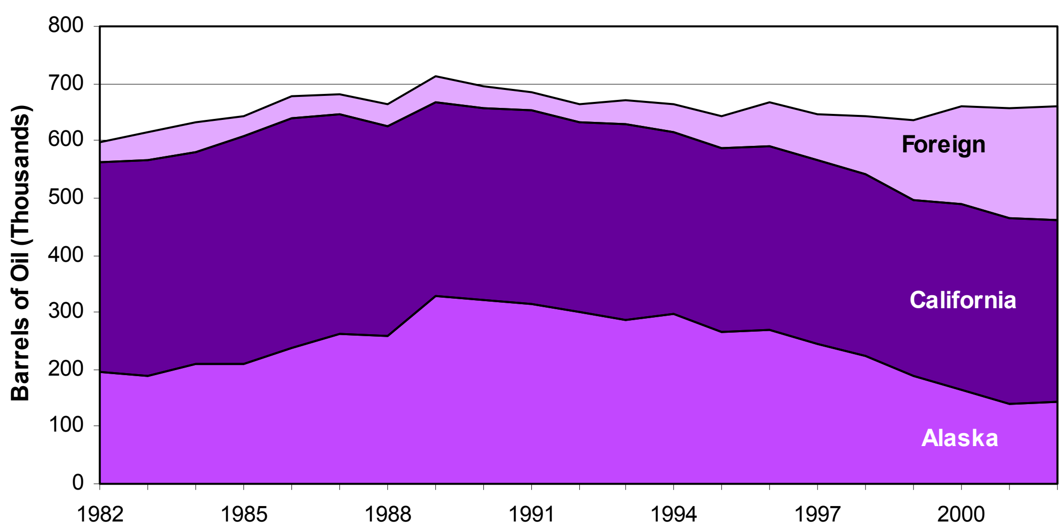
CHAPTER 3: TRANSPORTATION ENERGY SUPPLY

California's transportation fuel supply industry is evolving from primarily being able to provide fuels from in-state refining to an industry that is increasingly having to import crude oil and finished products fuels from foreign sources.

SOURCES OF PETROLEUM FOR CALIFORNIA REFINERIES

Californians currently consume approximately 42 million gallons of gasoline per day. According to the Energy Commission forecast, that consumption will grow to 55 million gallons of gasoline and nearly nine million gallons of diesel per day by 2023 assuming current trends continue. California imports gasoline and blendstocks to meet demand. California also imports jet fuel, diesel, crude oil and ethanol. Approximately 11 percent of California's gasoline production is exported to Nevada and Arizona to meet their transportation fuel needs. California acquires crude oil from within California and imports the rest from Alaska and foreign sources. As shown in **Figure 3-1,** in recent years, supplies of crude oil from within California and from Alaska have been declining, requiring California to import an increasing proportion of its crude oil from foreign sources.[7]

Figure 3-1
Oil Supply Sources to California Refineries

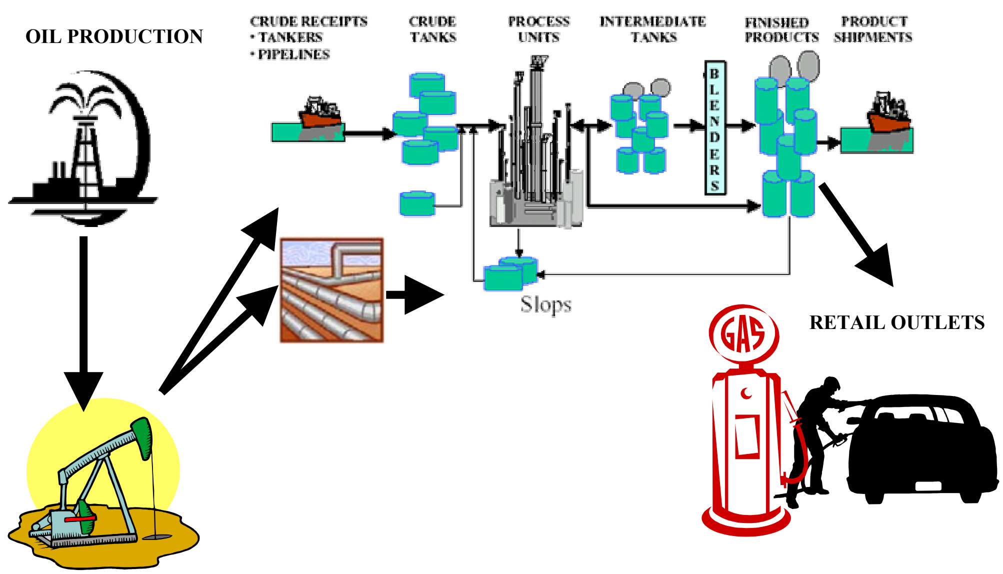


CURRENT SUPPLY

California's supply of transportation fuel involves the importation of crude oil and unfinished product components which in-state refineries manufacture into finished product as well as the importation of finished product. Imports, i.e., crude oil, unfinished and finished products, arrive via marine, and rail delivery systems.

As shown in **Figure 3-2**, California's petroleum infrastructure consists of refineries, terminals (some of which are marine facilities), distribution terminals, and storage facilities. Pipelines connect the refineries, to the marine docks and tanks, and to the inland distribution terminals. From the oil well the product flows through a variety of delivery mechanisms, including tankers and pipelines. Crude oil is stored in large tanks until it is needed at the processing units. Other products needed to manufacture transportation fuels are delivered by rail and/or pipeline to the processing units and then transferred to intermediate tanks to await final processing. Blending components are added and the fuels are stored in tanks until needed by the retail stores that sell fuels. Products sold to other regions of the U.S. are moved via barges, tankers or pipelines to their final destination.

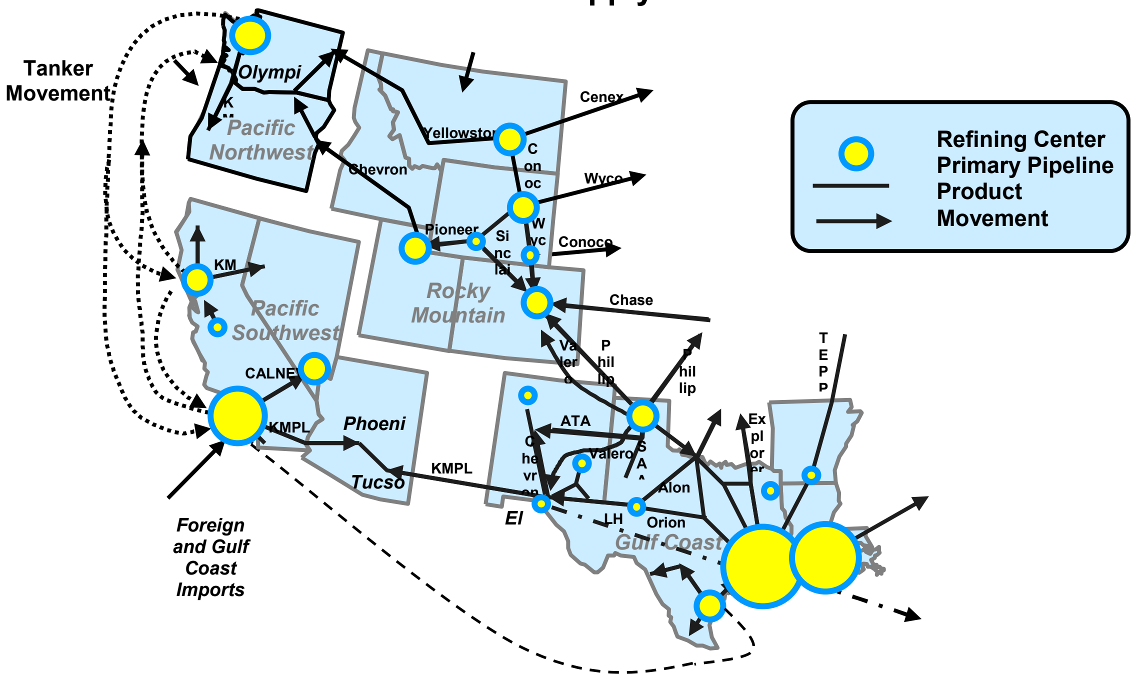
Figure 3-2
From Well to Wheels



Transportation Fuel Supply Sources

Figure 3-3 shows how crude oil, finished and unfinished products are supplied to California and other regions of the U.S.[8] These products move from refining centers throughout the U.S. to and from California via a network of pipelines, tankers and barges.

Figure 3-3
Western Supply Network



Refineries

California has two distinct refining centers in Northern and Southern California. Since there are no pipelines connecting these two primary refining centers, petroleum products are moved between them by coast barges, adding to marine infrastructure requirements.

As listed in **Table 3-1,** California has 22 in-state refineries located in or near two refining centers. Not all of these refineries produce gasoline.[9] Fifty-nine percent of the fuel products made by these refiners is gasoline for the California market. The remainder is jet fuel, distillates, residual fuels and gasoline for markets outside California.

Table 3-1
California In-State Refinery Product Capacities by Location

NAME & LOCATION	CRUDE OIL CAPACITY (Barrels Per Day)	MAJOR PRODUCTS
BP (formerly ARCO) - Carson	260,000	Gasoline, Diesel, Jet Fuel, Residual Fuel
Chevron Texaco – El Segundo	260,000	Gasoline, Diesel, Jet Fuel, Residual Fuel
Chevron Texaco – Richmond	225,000	Gasoline, Diesel, Jet Fuel, Residual Fuel
Conoco Phillips – Wilmington	136,600	Gasoline, Diesel, Jet Fuel, Residual Fuel
Conoco Phillips – Rodeo	73,200	Gasoline, Diesel, Jet Fuel, Residual Fuel
Conoco Phillips – Santa Maria	41,800	Crude Oil Processing
Edgington – Long Beach	26,000	Diesel, Asphalt
Exxon/Mobil – Torrance	149,000	Gasoline, Diesel, Jet Fuel
Kern Oil – Bakersfield	24,700	Gasoline, Diesel, Asphalt
Lunday Thagard – South Gate	8,100	Asphalt
Paramount – Paramount	50,000	Gasoline, Jet Fuel, Residual Fuel, Asphalt, Blendstocks
San Joaquin – Oidale	24,300	Diesel, Residual Fuel, Asphalt
Santa Maria	9,950	Asphalt
Shell – Martinez	159,250	Gasoline, Diesel, Jet Fuel, Residual Fuel
Shell – Bakersfield	66,000	Gasoline, Diesel, Residual Fuel
Shell – Wilmington	98,500	Gasoline, Diesel, Jet Fuel, Residual Fuel
Tenby Inc.	2,800	Asphalt
Tesoro - Concord	166,000	Gasoline, Diesel, Residual Fuel
Valero (formerly Exxon) – Benicia	129,500	Gasoline, Diesel, Jet Fuel, Residual Fuel
Valero (formerly Ultramar) – Wilmington	80,887	Gasoline, Diesel, Jet Fuel, Residual Fuel
Valero (formerly Huntway) – Benicia	14,500	Asphalt
Valero - Wilmington	5,770	Asphalt
TOTAL IN-STATE REFINERY PRODUCT CAPACITY	**2,011,857**	

Since 1996, California petroleum production capacity has grown less than consumer demand. There has been some slow growth in California refining capacity since 1996 - about 1.5 percent per year on average. During major turnarounds, refiners can sometimes expand refinery capacity marginally through maintenance upgrades. Total in-state refinery production capacity is over two million barrels per day (calendar-day capacity). Most of the time, all of the state's refineries are operating between 85 and 100 percent of capacity.[10]

Product Tankers, Berths and Moorings

Tankers are an important source of supplies to bring petroleum products to California. The average volume a vessel carries is 275,000 barrels. Ships from the U.S. Gulf Coast travel to California via the Panama Canal to either Los Angeles or San Francisco. Typical one-way trip times are 21 to 23 days. Fleets loaded at a U.S. port that sail to another U.S. destination must be shipped on a domestic flag vessel in accordance with federal law (Jones Act). There are currently 64 vessels that meet this requirement. Some of these ships will be retired between 2001 and 2015 under the provisions of the federal Oil Pollution Act of 1990. New tankers that meet the provisions of the federal Oil Pollution Act of 1990, foreign tankers, or barges will have to be deployed or reassigned to deliver product.[11]

In the San Francisco Bay Area, the marine petroleum infrastructure is concentrated in the northeastern parts of the Bay, in Richmond, in San Pablo Bay and in the Carquinez Strait. Cargo deliveries are limited by the depth of the Bay, which restricts the size and load of the vessels moving through the Bay, particularly near the Pinole Shoals.

In the Los Angeles area, many refineries and terminals that are part of the marine petroleum infrastructure in the Los Angeles Basin are actually located up to ten miles or more inland and connected to the dock by pipelines. Expansion of terminals for handling containers from cargo ships have reduced the amount of space available for marine tankage.

Terminals (Marine, Distribution and Storage Facilities)

In Northern California there are storage terminals located within several refineries and marine terminals. There is roughly 55 million barrels of storage capacity in Northern California refineries and terminals. Southern California refineries and terminals have roughly 61 million barrels of storage capacity. There is an estimated volume of 1.4 million barrels of capacity additions that are in various stages of planning and construction in California. Increased private storage could result in more gasoline inventories available to the market during a supply disruption.

However, all of these storage projects have been undertaken with the use of existing permits. Future projects to construct additional storage tanks could require extensive environmental assessment and a lengthy approval process. The state's petroleum product infrastructure may be inadequate even with these new projects and the permitting process may unduly burden applicants and agencies and inhibit the deployment of infrastructure needed to support demand.

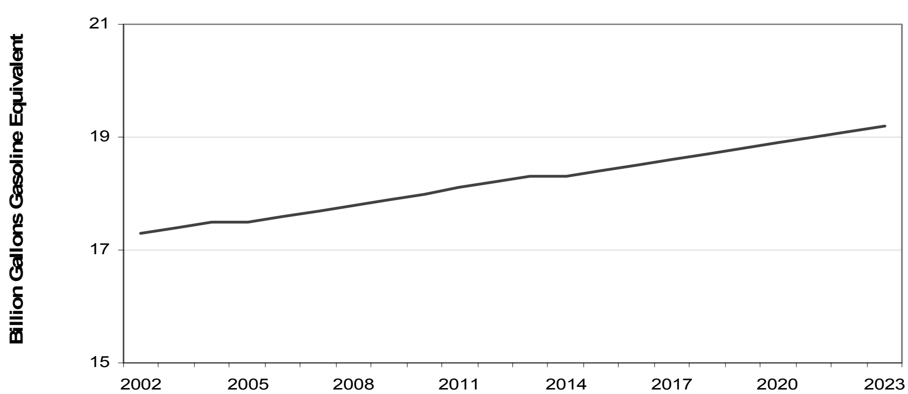
Petroleum Product Pipelines

The Southwestern United States (California, Nevada and Arizona) contains a number of petroleum product pipelines. The largest system is owned by Kinder Morgan, "common carrier" company, consisting of over 3,400 miles of pipeline (a "common carrier" company does not own the products shipped via its pipelines). The largest common carrier system transports refinery products to Nevada and Arizona. The same common carrier operates a pipeline system that moves product within California. There are two other proprietary pipelines that also move product within California. There are no pipelines that bring product to California. There were projects proposed for construction that could provide additional shipping capacity to the Southwest, however, some of those projects may no longer be actively under consideration. Supply lines to Southwestern states (California, Nevada and Arizona in particular) are important to having adequate fuel delivery infrastructure. The availability of supplies to the Southwestern states may relieve some of the need for California's refineries to export product outside of California and free up some product for in-state supply.

FUTURE SUPPLY

The Energy Commission forecasts demand for transportation fuels will grow as much as 35 percent over the next 20 years. Refineries located within California will likely be able to incrementally increase their production of fuels. **Figure 3-4** shows the estimated growth in gasoline and diesel supply from existing in-state refineries.[12] The future growth is a result of production capacity growth from operational and process improvements, which historically has grown 1.5 percent per year. However, it is unlikely this increased production will be sufficient to meet the forecasted growth in demand.

Figure 3-4
Estimated Supply from In-State Refineries



California will, increasingly, need to rely on importing fuels to provide sufficient quantities to meet future demand. As shown in **Figure 3-5 and 3-6,** industry experts estimate that

California will need to secure three times more gasoline and diesel from outside of California than it currently imports within the next 10 years from now.[13]

Figure 3-5
Actual Past and Potential Future California Gasoline Import Requirements

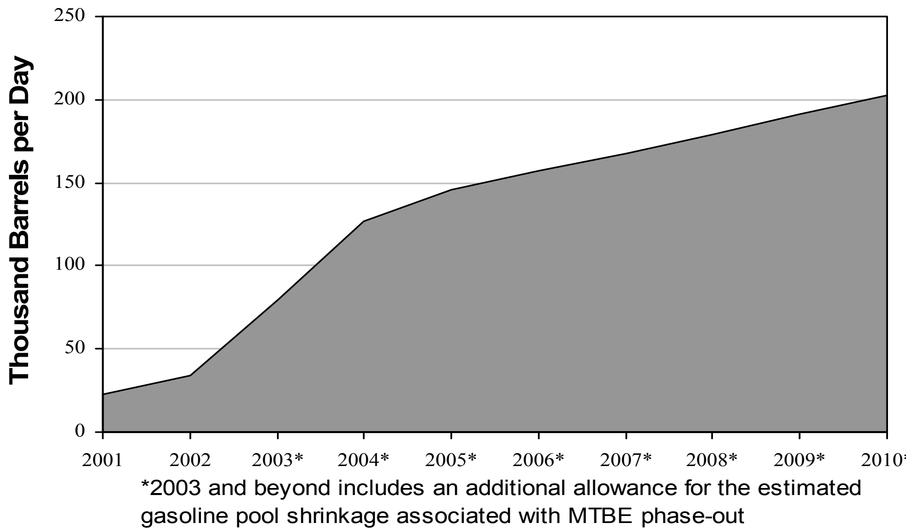
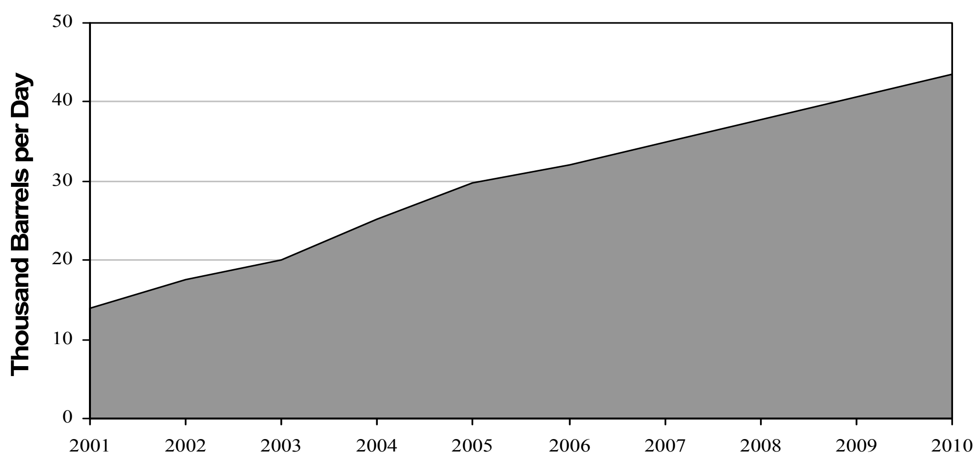


Figure 3-6
Actual Past and Potential Future California Diesel Import Requirements



In order to increase imports into California, the marine and storage infrastructure must be able to accommodate product transfers off of vessels and into the storage and distribution system.

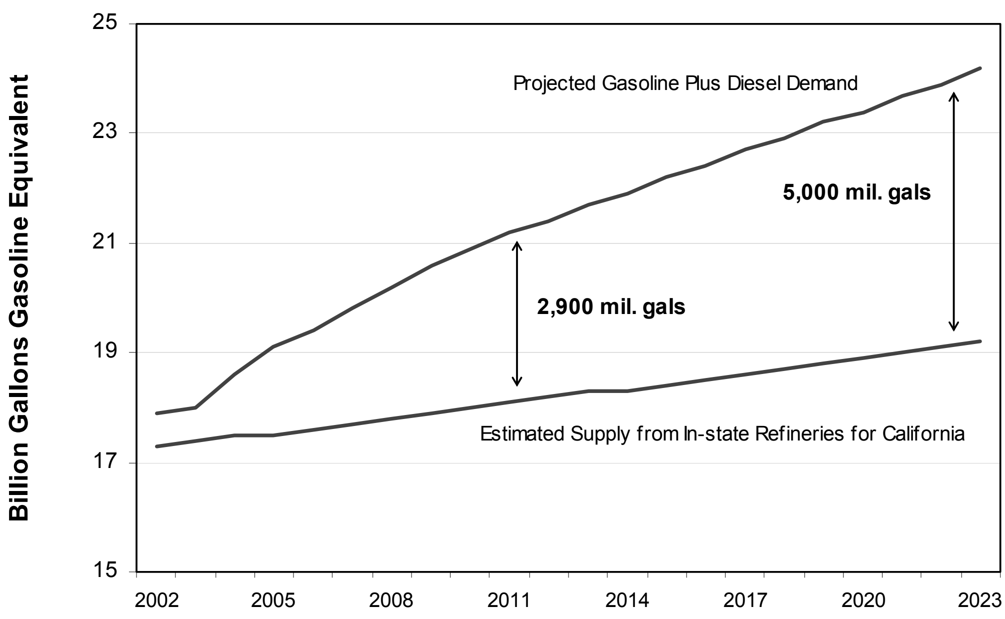
CHAPTER 4: TRANSPORTATION SUPPLY AND DEMAND BALANCE AND ISSUES

The gap between transportation fuel supply and demand will continue to widen as California's transportation fuel production industry is unable to increase its refining output to meet California's growing demand for gasoline and diesel fuels. If the transportation fuel production industry cannot provide sufficient fuel supplies, California will continue to experience volatile price and supply disruptions. There are current and future situations and issues confronting the refining industry and California's ability to mitigate and reduce continued supply disruptions and price volatility.

CALIFORNIA'S FUTURE TRANSPORTATION FUEL SUPPLY AND DEMAND

Figure 4-1 shows that in-state refining production of gasoline and diesel, will not be able to provide sufficient fuel for California's growing future demand even with continued refinery improvements.[14]

Figure 4-1
Projected Transportation Demand versus Supply



The Energy Commission forecasts that total gasoline and diesel use will increase by almost 35 percent over the next 20 years.   In-state fuel production will not be able to keep up with California's increasing demand and will need to import an equivalent of over 2.9 million gallons annually of gasoline and diesel fuel by 2010 and over five billion gallons annually by 2023. There are other significant considerations complicating the decision-making process of how to provide sufficient fuel to meet California's transportation fuel demand. In the near-term, the considerations are primarily environmental; such as replacing methyl tertiary-butyl ether (MTBE) as an oxygenate additive to gasoline and meeting future lower sulfur diesel regulations. In the longer-term, the considerations focus on being able to rely upon sustainable energy resources and reducing the state's contribution to greenhouse gas emissions.

NEAR-TERM ISSUES

Several near-term issues may impact the supply and price of transportation fuels in California:

- A petition for waiver filed by the State of California to allow the use of non-oxygenated gasoline in certain areas of California.

- Pending legislation in Congress to modify the Federal Energy Policy Act.

- A 2006 requirement to reduce sulfur content in diesel fuels throughout the U.S.

- Supply disruptions and volatile fuel prices will continue.

- There is a need to increase gasoline and diesel fuel supplies to meet growing demand.

Federal Oxygenate Requirement

The State of California petitioned the U.S. Environmental Protection Agency (U.S. EPA) for a waiver from federal law requiring the use of oxygenated gasoline in ozone non-attainment areas. In California, these non-attainment areas include the South Coast Air Basin and the Sacramento region. The U.S. EPA denied this petition, prompting the state to appeal the decision to the Ninth Circuit Court of Appeals. On July 17, 2003, the court rendered an opinion vacating the U.S. EPA's denial and ordering the agency to reconsider California's waiver request. As a result, California will continue to pursue a California waiver from U.S. EPA's oxygenate requirements.

Pending Federal Legislation to Modify Energy Policy Act

Congress is deliberating new national energy legislation that includes major provisions relevant to the state's ethanol-based gasoline supply. The current language includes:

- Requirement for a Renewable Fuel Standard (RFS). Requires gasoline sold in the U.S. (except Alaska and Hawaii) to contain renewable fuel, beginning at a volume of 2.6 billion gallons per year in 2005, increasing each year to 5 billion gallons per year by 2012.

- Restrictions on the use of MTBE. Prohibits the use of MTBE in gasoline four years after enactment, except in states that act to specifically authorize its use.

- Elimination of Oxygen Content Requirement for Reformulated Gasoline. Strikes the Clean Air Act's requirement for use of oxygenated gasoline in air quality non-attainment areas.

Much of the discussion surrounding the provisions of the pending 2003 Energy Policy Act involves the supply and price of ethanol and the effect on California's gasoline.

- Ethanol Supply Adequacy. The RFS requirement for five billion gallons of ethanol use nationwide by 2012 should, based on Energy Commission staff's analysis of the ethanol manufacturing industry, be met by domestic U.S. production sources.

- Ethanol Price Impact on Gasoline Prices. Increasing demand for ethanol to meet the increasing requirements of a national RFS could create upward pressure on ethanol prices. However, the price of ethanol used as a 6 to 10 percent gasoline additive stands to modestly impact gasoline prices.

The price and supply of ethanol are important components and in the near-term, are critical to ensuring safe and affordable supply of gasoline. The Energy Commission will continue to monitor the enactment and implementation of this pending legislation and its impact on California's transportation fuel price and supply.

Federal Low Sulfur Fuel Specification[15]

In 1999, The U.S. EPA issued a rule to reduce sulfur content in gasoline that most refiners and importers must meet a corporate average gasoline sulfur standard of 120 parts per million (ppm) and a cap of 300 ppm beginning in 2004. The effect of this new rule will likely be a slightly higher price (estimates are around $0.03/gallon) at the pump across the country for gasoline. The higher price will likely be a result of the cost of refinery technology upgrades as well as possibly fewer refiners manufacturing fuel that meet this specification. There is also a potential supply issue regarding transportation of the new fuel through the existing pipeline in a manner that does not change the fuel sulfur content.

The U.S. EPA also issued a rule to reduce sulfur content of highway diesel fuel from 500 ppm to 15 ppm. The new fuel must be available at retail stations by September 1, 2006, although a phase-in option allows up to one-fifth of all diesel fuel produced to meet a limit of 500 ppm through early 2010. This new requirement is expected to increase the price of diesel fuel by as much as ten cents per gallon beginning in September 2006. Supply shortages and/or disruptions in the flow of product generally lead to price spikes. It is likely that the new requirement will contribute to higher price volatility, particularly during the transition period from the current fuel specification to the new fuel specification. The volatility will likely be a result of fewer refiners manufacturing diesel that meets this new specification and transport issues in moving the new fuel through the existing pipeline transport system.

The California Air Resources Board (CARB) has recently adopted a rule to implement the same federal sulfur limits, but requiring a lower-aromatic limit by June 2006.

Affordable diesel price and reliable supply is crucial to California's agriculture and transportation industries. Issues related to implementing the changeover to lower sulfur diesel may arise that may cause supply constraints. In particular, current refineries may not be able to produce diesel fuel under this new standard. The Energy Commission will continue to monitor the progress of refineries to meet the CARB regulation, as well as other states' implementation progress.

Continuing Price Volatility

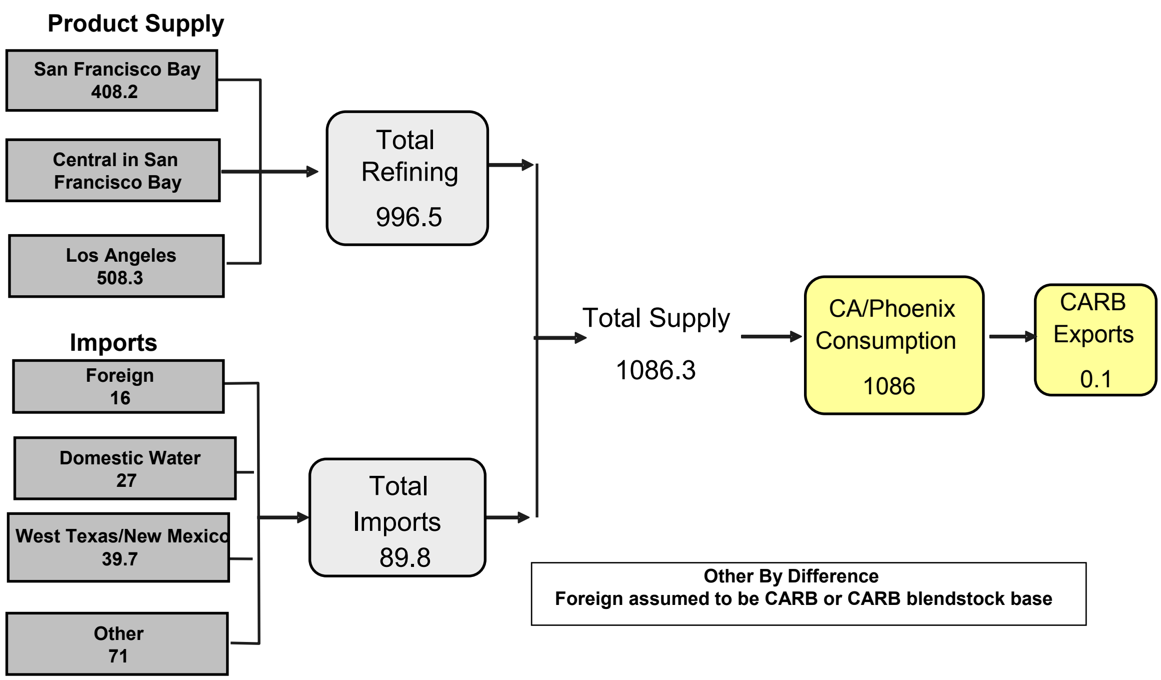
The supply of transportation fuel involves the combination of deliveries of product components (crude oil and blendstocks) to in-state refineries via pipelines, cargo ships, rail, barges and trucks. Finished transportation fuels use the same delivery mechanisms and are then stored as inventory in terminals located in California.

As recent history shows with past price spikes, any disruption of this system can lead to price spikes and the need for new short-term sources of supply to make up for fuel lost as a result of the disruption. While the system is complex, it does provide, to some extent, means that allow fuel suppliers to make up short-term product deficits through inventory storage and pipeline distribution systems. Supply disruptions leading to price spikes will continue, given current conditions. The Energy Commission has analyzed the issue and identified actions to mitigate future price spikes.

Increasing Gasoline and Diesel Fuel Supplies

Figure 4-2 shows the quantities of the current supply and distribution for gasoline and diesel fuel for California, including Arizona, which meet current transportation fuel demand.[16] As demand grows, supplies will come increasingly from imports. Refinery production improvements and potential pipeline capacity increases from the Southwest will be able to meet some of the growing demand. However, given forecasted demand growth, it is not certain if sufficient supplies will be available. If the gap between demand and supply is not closed, future transportation fuel prices will be higher and price volatility will be more frequent and extreme.

Figure 4-2
California and Phoenix Gasoline Supply and Distribution
(Million Barrels per Day)



LONGER-TERM ISSUES

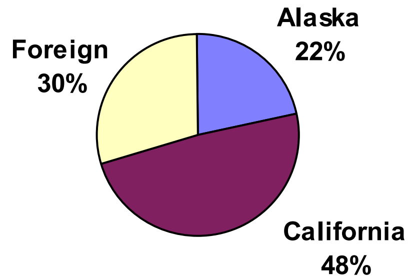
Two issues that have significance for the longer-term are:

- Timeframe when world oil production peaks.
- Transition to a sustainable transportation future.

World Oil Supply

As shown in **Figure 4-3**, in 2002, California refineries' crude oil supplies came from in-state sources (48 percent). Alaska accounted for 22 percent, and foreign sources for 30 percent. Regardless of the source of crude oil, prices from all these sources tended to rise and fall together, the differences in price taking into account premiums for the differences in quality.

Figure 4-3
Sources of Crude Oil for California Refineries 2002



In the past, politically induced disruptions have been the primary cause of world crude oil price spikes. These price increases often endure for short periods of time after which prices return to their historical averages.

Figure 4-4 shows the United States Geological Survey (USGS) petroleum assessment indicates an "ultimate resource base" of conventional oil of three trillion barrels.[17] Ultimate resource base includes historical production, current proved reserves, possible reserves growth at existing fields, and further undiscovered resources that will be added to reserves. This does not include frontier areas, small accumulations, or substantial unconventional resources, such as heavy oil and oil sands or methane hydrates. Just under one-half of this base has already been produced.

Figure 4-4
World Petroleum Assessment

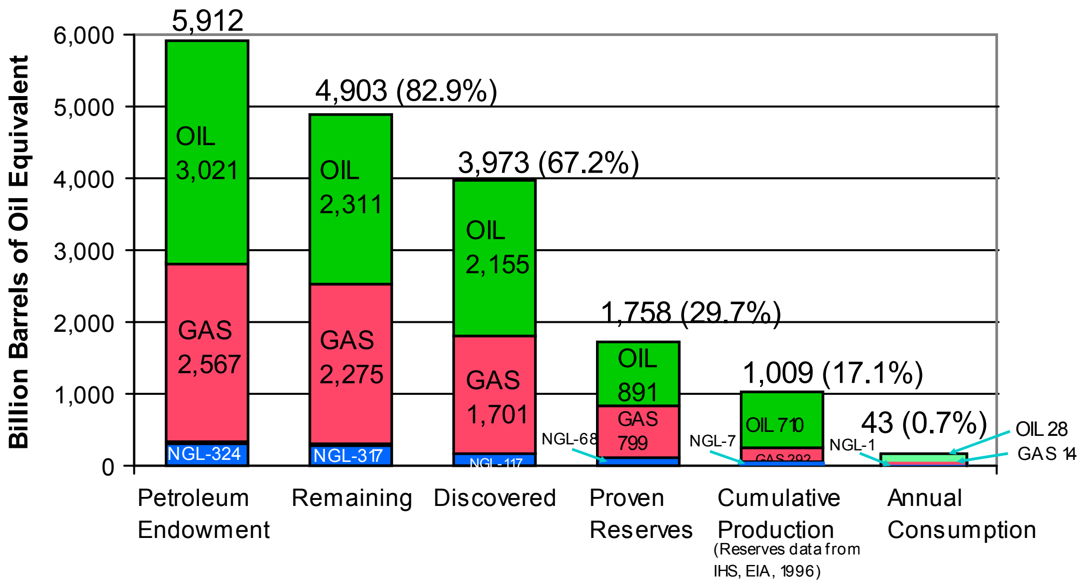
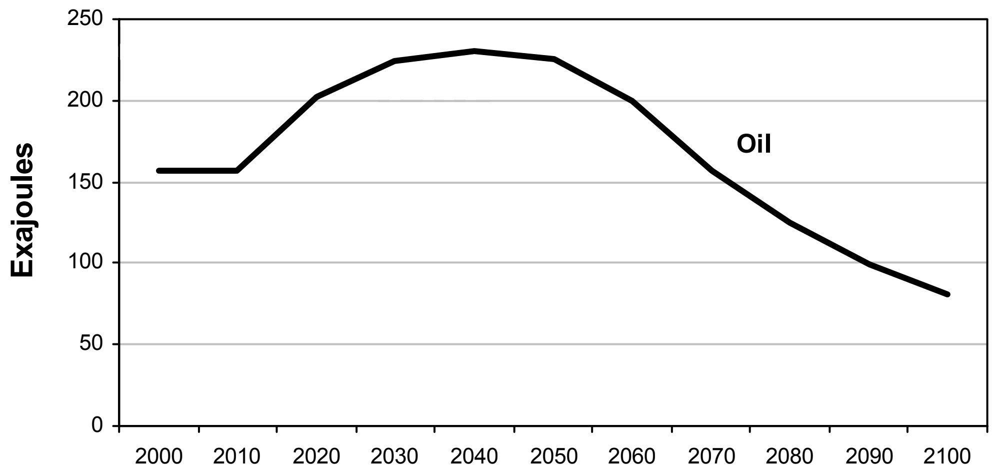


Figure 4-5 presents a USGS scenario of a world oil production peak.[18] Depending upon USGS assumptions regarding future discoveries and rate of consumption, world oil

production could peak as soon as 2020 but perhaps as late as 2040. However, this time period can shift depending upon increasing petroleum demand and/or reductions in demand for petroleum products throughout the world. Additionally, more proven reserves could be developed in the future through heavy oil and oil sands or improvements in oil recovery technology could increase production. These additional reserves will be developed if the economics show that there is a benefit to investing in their recovery.

Figure 4-5
Estimate of World Oil Production Peak



California is a major consumer of petroleum and will become increasingly reliant on foreign sources of petroleum. The future availability of world oil supply is a concern to maintaining affordable fuel supplies to California. Experts offer varying opinions on whether a production peak will occur; and if there would be a peak, the timeframe that a production peak would occur.

The Energy Commission will monitor the world oil supply market to provide as much advance planning opportunity to respond to significant changes in world oil production. Based on expert opinions, the Energy Commission will undertake monitoring activities of production profiles, especially for countries that may be nearing their production peaks, reserves to production ratios, industry and related financial markets, global oil substitution and demand reducing trends, and OPEC market share trends.

Petroleum Dependence

As California's future population and economic output grow, our demand for transportation services and fuels also grow. The Energy Commission has forecasted that total gasoline and diesel use will increase by almost 35 percent over the next 20 years. While in-state refining capacity continues to grow to meet increasing demand, it will not be able to keep pace with the rate of future demand growth. Without increasing the fuel supply infrastructure to import additional gasoline and diesel fuel supply, California will continue to experience sudden price increases for both gasoline and diesel fuels.

California will experience even greater economic and environmental burdens if it continues to rely exclusively on its current transportation energy supplies and does not develop other energy resource options.

Historically, California has obtained supplies of petroleum from in-state production, imports from Alaska and imports from foreign sources. In-state and Alaskan supplies have been and will continue to be in decline. This has resulted in California's growing reliance on foreign imports to meet its transportation fuel needs. Like Alaska and California petroleum resources, foreign imports will also reach a peak in production before declining. Experts, at this time, continue to debate the timeframe that world petroleum resources will peak based on known and available data. Some experts believe the petroleum peak will occur in the next 10 to 20 years. Other experts and the oil industry maintain technological improvements to extract petroleum, economics and additional discoveries will extend the peak well into the next century.

Energy resources needed to meet California's transportation energy demand will be fossil fuel-based, in that they will contain carbon and other greenhouse gases. Greenhouse gas emissions from human activities are causing dangerous warming of the earth's atmosphere, which has resulted in significant economic, environmental, and ecological impacts. As the effects of climate change intensify, transportation fuel options will need to focus on efficiency improvements and fuels and energy sources with potential for lower greenhouse gas emissions.

Can California have a transportation energy market that can provide adequate and cost-effective sustainable transportation fuels by transitioning from petroleum as its predominant source of energy to other sources, as well as decrease demand for transportation fuels by developing more efficient means of using those fuels?

CHAPTER 5: CALIFORNIA NEEDS TO REDUCE ITS VULNERABILITY TO SUPPLY DISRUPTIONS AND PRICE SHOCKS

California has experienced short-term price spikes over the last several years as a result of physical constraints in California's marine infrastructure and the transportation fuel industry's storage capacity. Removing these constraints will allow for adequate and flexible supplies of gasoline and diesel fuels, which can significantly reduce price volatility.

RISK OF SUPPLY DISRUPTIONS AND PRICE SHOCKS

In the last few years, California motorists have experienced significant short-term increases, or "spikes" in the price of gasoline. The state's gasoline refineries are operating at near maximum production, and when an unplanned refinery outage occurs, especially when gasoline inventories are low, the price of gasoline can spike. Outages drive the price higher because of the temporary imbalance between supply and demand. The price increase required to restore this balance can be significant due to a very low demand response—California motorists have little alternative to gasoline use in the short run.

Gasoline sold in California requires a unique, less-polluting formulation. This means that sources of supply outside the state are limited. Since California is not connected by pipeline to major refinery centers elsewhere in the country, imported gasoline must be brought in by marine tanker. In the event of an in-state supply disruption, locating and importing replacement gasoline can take from two to six weeks. Prices often remain at high levels until shortly before these additional supplies arrive.

CONSEQUENCES ON AVAILABILITY AND PRICE OF FUELS

California's gasoline price volatility, of which price spikes are the most obvious feature to motorists, can result in prices significantly higher than in the rest of the country. The difference in retail prices between California and other regions, typically 5 to 20 cents per gallon, can increase to 50 cents or more per gallon as a result of in-state supply disruptions. During the latest price spike episode in early 2003, average retail prices in California increased by 57 cents per gallon and reached levels 40 cents higher than average prices elsewhere in the U.S.

Gasoline is a commodity that is bought and sold in wholesale, or "spot," markets. Market traders purchase gasoline, in bulk, for a certain price. A trader can sell that bulk gasoline at a set price when the cargo is delivered. Depending on the demand for the cargo when it arrives (which is based on a combination of consumer demand and current inventory levels) the cargo can have less or more value than when it left its site of origin.

The most noticeable times when cargos can gain value is when the state's refineries experience supply disruptions. Prices will remain high for a short period of time and then fall when the refinery is repaired and/or imported cargos arrive. At times like these, consumers will pay more for transportation fuels. Similarly, when there are few supply disruptions or refinery outages and inventories are plentiful, consumers will benefit with lower prices for transportation fuels. **Figure 5-1 and 5-2** show the relationship between the value of future prices and level of gasoline supply inventories. **Figure 5-1** plots the daily one-month forward or projected future price minus the spot or actual price for 2002.[19] The points labeled 1, 2, and 3 indicate when the forward price was much lower than the spot price.

Figure 5-1
California One Month Forward Price Minus Spot Price
January 2002 - December 2002

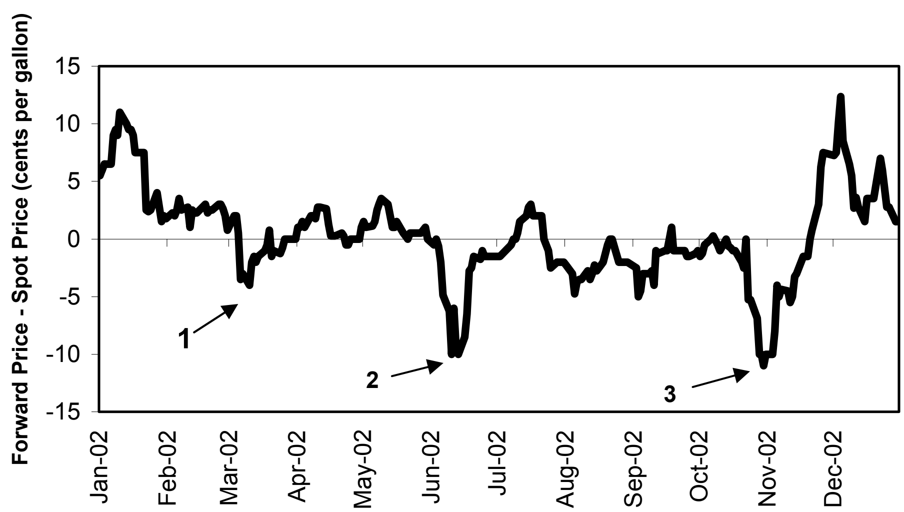
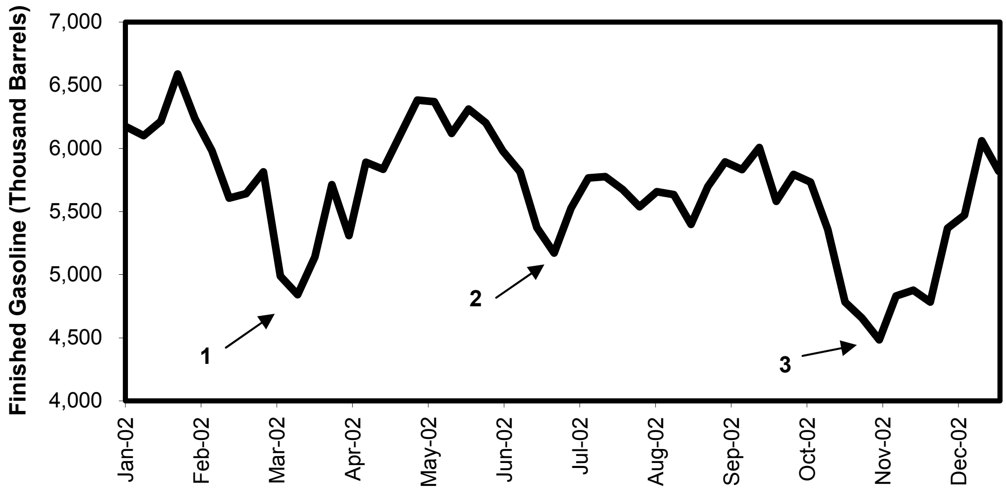


Figure 5-2 shows average weekly inventory holdings for the same year. As the points labeled 1, 2, and 3 on each graph indicate, inventories are drawn down sharply when the forward price is much lower than the spot price.

Figure 5-2
California Weekly Total Gasoline Inventories January 2002 - December 2002

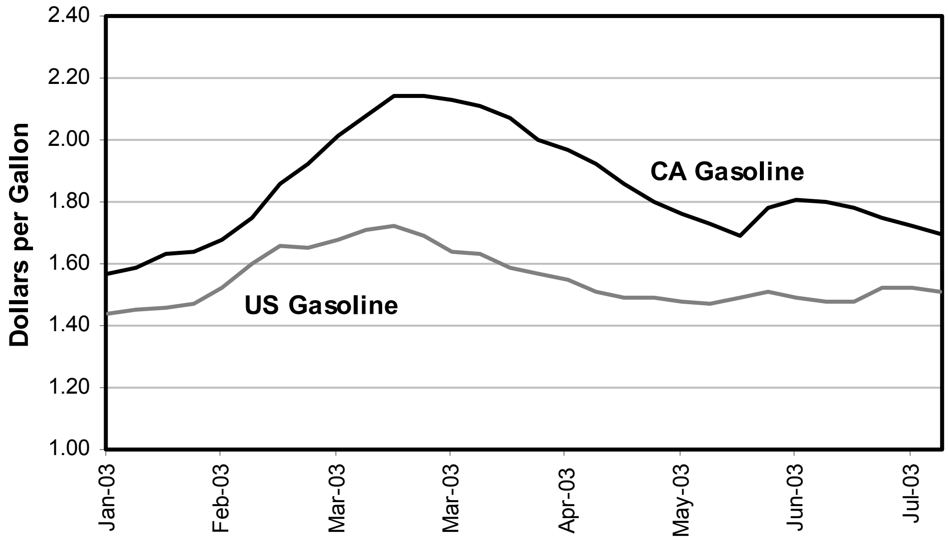


California's gasoline markets will continue to be subject to occasional price spikes for the indefinite future. When unanticipated refinery outages occur in conjunction with low gasoline inventories prices can spike significantly until additional supplies are obtained. These supplies are often imported by ocean tanker from refineries overseas and can take three to six weeks to arrive. Gasoline price increases in early 2003 were driven primarily by unusually high crude oil prices due to the impending threat of war in Iraq. Other contributing factors included an oil strike in Venezuela and a cold winter in the Eastern U.S. that increased demand for heating oil.

Circumstances unique to California also contributed to higher gasoline prices in the spring of 2003. There were some concerns in the industry that California refiners were having difficulty making gasoline that could meet new summer specifications. Although the phase-in of ethanol ultimately went smoothly, rumors and speculation around this issue caused significant upward pressure on gasoline prices in California. In addition, gasoline supplies where especially tight during this time frame because several California refiners were down for maintenance longer than originally anticipated.

Figure 5-3 shows the impact these events had on the price of gasoline in early 2003. Average U.S. retail prices rose from \$1.44 to \$1.73 per gallon in ten short weeks. At the same time, California gasoline prices rose even more precipitously, from \$1.58 a gallon on January 1, to a record setting \$2.15 a gallon on March 17 as displayed in Figure 3.

Figure 5-3
Retail Gasoline Prices – California versus U.S. All Formulations
January 2003 - Present



CONSEQUENCE ON NEAR-TERM SUPPLY

In response to continuing periods of gasoline price volatility and their impact on consumers, the Attorney General formed the Gasoline Price Task Force to examine the causes of price spikes. The results of the Task Force study are described in *Report on Gasoline Pricing in California*, issued in May 2000.[20] The report recommends that the state investigate the possibility of a "strategic fuel reserve," consisting of gasoline kept in public storage tanks that would be available to private suppliers through a daily auction. The intent behind such a reserve is to make additional gasoline available to the California gasoline market during supply disruptions, and thereby reduce, or "dampen," price spikes. This recommendation led to the passage of Assembly Bill 2076.

Assembly Bill 2076 (Shelley, Chapter 936, Statutes of 2000) directed the Energy Commission to assess the feasibility of operating a state strategic fuel reserve (SFR) to insulate consumers and businesses from the substantial short-term price increases arising from refinery outages and other in-state supply disruptions.

The Energy Commission sponsored a study to measure the potential benefits to California consumers from reduced expenditures on gasoline *if* a strategic fuel reserve could dampen price volatility. The study, which assumed that the SFR would work as envisioned, analyzed the probability of refinery outages to estimate the costs of price spikes to consumers in a typical year. Assuming that a reserve would eliminate spikes above ten cents per gallon, the study estimated a "base case" annual benefit to consumers of $400 million. With different assumptions from the base case, the study yielded a range of potential benefits from $140 to $607 million per year.

To provide benefits to California consumers, an SFR must significantly increase the amount of gasoline available in the market during a refinery outage or other event in order to effectively mitigate a price spike. In addition, an SFR would introduce a new dynamic into the California gasoline market that would offset the benefits of an SFR to the California motorist.

The Energy Commission found that a strategic fuel reserve, however, could have several unintended consequences, which could limit its effectiveness as a tool to moderate gasoline price spikes and could reduce the total supply of gasoline in the state:

- A reserve could displace private inventories,
- A reserve could offer profit-making opportunities that would reduce its effectiveness, and
- A reserve could reduce the total supply of gasoline in California.

In addition, the Energy Commission has determined that investment in private storage capacity is increasing, which reduces the need for an SFR.

Options to Reducing Price Volatility

Severe price volatility is likely to continue in California, at least for the next few years. Therefore, to reduce price volatility, the Energy Commission considered the following alternatives to an SFR:

- Stimulate the California gasoline forward market through state participation,
- Identify the steps necessary to enhance the state's marine infrastructure, and
- Streamline the storage infrastructure permitting process.

State Participation in Forward Markets

The intent in the first alternative is to increase liquidity (the number of trades) in the gasoline forward market through state purchases of forward contracts. If more buyers of forward contracts were available, importers, who sell forward contracts, might find it easier to hedge the risk that gasoline prices could fall while the cargo is in transit. Importers might then be willing to bring more cargos into California, which could increase available supply during a disruption.

A study sponsored by the Energy Commission compared the California forward market for gasoline with other forward markets.[21] The study found that neither the number of trades nor the number of participants in the state gasoline forward market appears to be especially low in comparison with other forward markets. In addition, the study found little evidence that a lack of liquidity in the forward market impairs prospective importers.

Identify the Steps Necessary to Enhance Marine Infrastructure

The Energy Commission sponsored a study of California's marine infrastructure to assess its ability to accommodate imported petroleum products.[22] The study identified the current and future constraints within the system of wharves, storage tanks, and pipelines that could impair the ability of importers to deliver cargos to the state. The Energy Commission believes that these constraints do impact imports of gasoline, and that this may reduce the supply of gasoline available during a disruption.

California imports both crude oil and petroleum products to meet state demand for fuels. Over the next five to ten years, demand for gasoline is expected to grow at a rate of almost two percent per year, while the capacity of California refineries to produce gasoline is not expected to keep pace. Consequently, imports of gasoline as well as crude oil will need to increase.

The study for the Energy Commission indicated that the state marine infrastructure for petroleum products is at or near the limits of throughput capacity, and unless the infrastructure is expanded, additional imports will increase marine congestion in California. The potential problems are most serious in Southern California, where the bulk of the increased quantities of imported crude oil and refined petroleum products will be received.

Marine vessels require storage tanks of sufficient capacity to be able to offload their cargos in a timely manner, avoiding costly demurrage fees and reducing the risk of creating additional scheduling conflicts for other vessels. Access to storage tanks is especially limited in Southern California. In particular, two of the three facilities used to receive gasoline and gasoline blending for gasoline are highly utilized and constrained by bottlenecks that prevent increased imports.

If these constraints and bottlenecks can be alleviated to some degree, imported gasoline supply could reach the California market more quickly during a refinery outage, helping to dampen price volatility. On the other hand, if marine infrastructure capacity does not expand, volatility could become even more severe.

The length of time and the complexity of acquiring permits to construct facilities is of concern to the extent that it impacts the affordable and reliable supply of transportation fuels. Ensuring that needed marine and storage facilities are successfully constructed and placed in operation as the demand for transportation fuel storage is essential to providing affordable and reliable supply of transportation fuels.

Streamline the Storage Infrastructure Permitting Process

The Energy Commission is aware of 1.4 million barrels of private storage capacity that are either under construction or where construction is planned in the next several months.[23] Thus, conditions in the California gasoline market may improve slightly in the near future.

Increased private storage could result in more gasoline inventories available to the market during a supply disruption.

However, all of these storage projects have been undertaken with the use of existing permits. Future projects to construct additional storage tanks could require more extensive environmental assessment and a lengthier approval process. Based on an Energy Commission survey of the petroleum industry, the state's petroleum product storage infrastructure is still inadequate, even with these new projects, and that the permitting process may unduly burden applicants and agencies.[24]

The high costs of the permitting process result in a shortage of storage capacity. These costs lead to higher lease and rental rates for tanks, so gasoline suppliers hold lower inventories than they might otherwise choose. This results in lower inventory available during a refinery outage and therefore more gasoline price volatility. In addition, higher lease and rental rates raise the operating costs to suppliers, resulting in higher average market prices.

The Energy Commission sponsored a detailed study on the permitting of petroleum product storage facilities.[25] The study examined the process by which petroleum industry participants obtain the permits required for the construction or acquisition of petroleum product storage facilities. In addition, the study identified bottlenecks, redundancies, and unnecessarily burdensome regulatory processes, and recommended improvements in the permitting process.

The Permit Streamlining Act (PSA) establishes strict timelines for agencies to conduct permit application reviews and issue decisions. The PSA requires state and local agencies to list the information and criteria that they will use in evaluating a permit application. These timelines are frequently not met, without penalty to the permitting agency. Little effort appears to be made to comply with the PSA, since the PSA is not very well known among stakeholders in the permitting process. No agency within California is responsible to implement the PSA, and this appears to be a fundamental problem. This issue is very complex, but a permitting process solution could yield significant benefits by eliminating duplicative efforts on the part of agencies and applicants and providing a time-certain process with decision-making authority.

The state has dealt with similar problems in the past. In response to concerns about the power plant siting process, the Legislature passed the Warren-Alquist Act in 1974, establishing a state permitting agency for power plants. The legislation gave the Energy Commission exclusive authority over thermal electric generating power plants 50 megawatts or larger as well as related facilities such as transmission lines. As a result, the Energy Commission developed a 12-month process for certification of applications.

As the lead agency under the California Environmental Quality Act (CEQA), the Energy Commission is required to consult with responsible local, state, and federal agencies as part of its review process. The Energy Commission's power plant licensing process has proved to be very effective in assuring the timely review and approval of new generating capacity in California because it: 1) consolidates all state and local agencies into a single permitting process, 2) has the ability to override other state and local agency decisions, 3) involves extensive public participation, and 4) has a certified CEQA equivalent review process.

CHAPTER 6: ADDITIONAL FUEL SUPPLIES ARE NEEDED TO MEET FUTURE DEMAND

There will be a significant and growing gasoline supply deficit that will need to be met by importing transportation fuels. Available information on potential supply options raise the concern that California may experience higher and more volatile fuel prices as a result of inadequate supplies being available in the near future.

TRANSPORTATION FUEL SUPPLY OPTIONS

To meet current California gasoline demand, as well as exporting gasoline products to neighboring states, an additional 3.5 million gallons of gasoline and blendstocks per day must be imported. Given estimated in-state refining capacity growth, projected gasoline and diesel fuel demand will create an annual supply deficit of 2.9 billion gallons by 2010 and 5 billion gallons by 2023. To eliminate the projected supply deficits, increasing levels of gasoline and diesel product and blend stock will need to be imported.

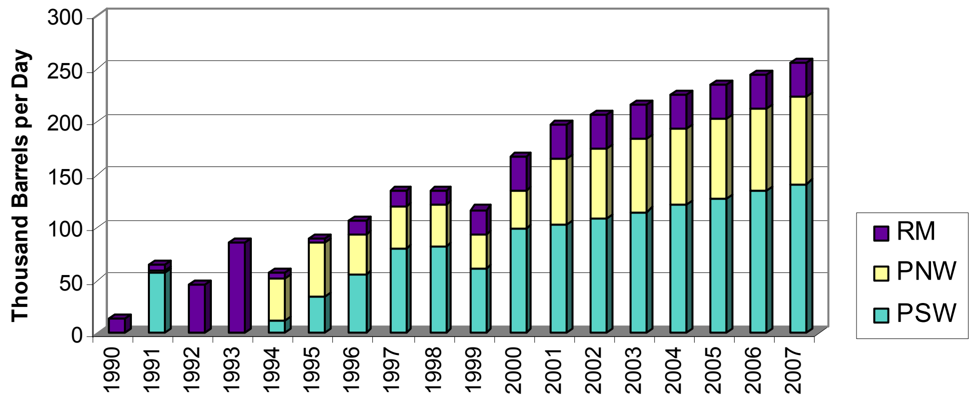
Potential actions for increasing supply include incremental production increases at refineries, port expansions to receive increased levels of imported products, additions to storage capacity in-state, increased pipeline infrastructure to California and/or the Southwest states and demand reduction measures (such as increased vehicle efficiency, and vehicle maintenance). If new refinery capacity is proposed to help increase supplies, California would need to ensure that port, storage and infrastructure can support the increased deliveries of crude oil and blending components.

Aside from these actions that can help increase transportation fuel supply to California, there may be actions that restrict increased supplies, such as the possible increase in demand for ethanol throughout the U.S. as a result of changes to federal law and the implementation issues related to federal and state lower sulfur diesel regulations.

Refinery Production

Output from refineries throughout the west has increased, without increasing the number of refineries. The refining industry has shown it is capable of increasing refinery output through improvements in refining technologies. **Figure 6-1** illustrates the refining industry's capability to increase productivity from existing facilities.[26] At this time, the ability of refiners to continue to increase their productivity and output is unclear.

Figure 6-1
Cumulative Incremental Production Pacific Northwest, Rocky Mountain and California Refineries Total Gasoline,
Thousand Barrels per Day, Base Year – 1989



Marine Imports

Imports via marine shipments will very likely be the way that California will meet its future transportation fuel supply needs. Marine imports can only be accomplished if space is available at docks for ships to berth, if the depth of the access waterways is sufficient to allow passage of large ships, and if storage for unloading and transferring materials is available. It will be important to monitor and evaluate the development of marine infrastructure to support increased deliveries of crude oil and transportation fuel products to California.

Pipeline System

Importing transportation fuel products into California could also come from the pipeline system. The pipeline system that serves the Southwestern states could be expanded to allow more product to flow to the Arizona and Nevada markets. One such project was planned but is currently on hold. This project, and others like it, are important to the extent that they reduce the demand on California refiners to export product to Arizona and Nevada. It is important to monitor projects that affect supplies of product that could impact the California supply situation.

Ethanol

As an important means for California to meet federal oxygenate requirements, the supply and demand for ethanol should be monitored. Possible actions that could impact the supply for ethanol include new federal legislation, if passed, would require all states to use ethanol or other states could opt to use ethanol as an oxygenate. Additionally, the California petition to relieve itself of the federal oxygenate requirement (except in certain geographic areas within California) will also impact the demand for ethanol. The potential impact of this action should also be monitored.

Low-Sulfur Diesel

Some refiners may choose not to manufacture low-sulfur diesel when the new federal lower-sulfur diesel fuel requirement takes effect. The impact on the supply and price of diesel in California must be monitored as this fuel type has an enormous impact on the agricultural and shipping industries in California. Additionally, the transfer of low-sulfur diesel via pipeline may impact delivery of other fuels when they are shipped via the same system. Those types of implementation issues that affect the supply may also increase price volatility and should be monitored.

TRANSPORTATION FUEL SUPPLY SUFFICIENCY

Given the important role that transportation fuels provide for Californians, in terms of the economy and quality of life, it is imperative that the state be fully informed on how private industry intends to supply future transportations demand needs. If shortfalls are identified, then the state can be positioned to take the appropriate actions to address shortfalls.

Some of the opportunities to maintain sufficient, secure and affordable supplies in the near term include, but are not limited to expanding marine infrastructure and increasing in-state transportation product storage capacity. In addition, there may also be opportunities to build product transfer systems, such as pipelines.

While it is clear that the state needs additional supplies of transportation fuels, it is not clear which of the options provide the best means of, or if sufficient supplies can be developed, to achieve that goal.

The best course of action would be to improve institutional understanding of the economic and physical structure of the refining, distribution, supply and retail aspects of petroleum industry through improved data collection and analysis. Several specific aspects affecting the supply of transportation fuels should continue to be monitored to assess their impact on maintaining sufficient, secure and affordable fuel supplies including, but not limited to:

- Industry transition to low-sulfur diesel standards,
- Price and availability of ethanol,

- Provisions of the Energy Policy Act (if enacted) that may further affect ethanol price and supply,
- Construction and expansion of facilities and equipment that manufacture, store, ship and deliver fuels.

While the Energy Commission receives data on current crude oil and petroleum product production, shipment, prices, inventory, and storage levels from refiners and major petroleum firms, the Energy commission does not have access to future expansion and construction plans to this industry. This information is highly proprietary and market sensitive and not publicly available due to the competitive nature of the industry. If the Energy Commission were able to confidentially acquire this information then the Energy Commission could determine if industry will or will not be able to provide adequate supplies to meet future transportation fuel demand. In addition, the Energy Commission would be able to determine bottlenecks and impediments to expansion and construction that might adversely impact the delivery of future transportation supplies and identify action that the state could assist the industry to bring future projects to fruition.

CHAPTER 7: SUPPLY AND DEMAND MEASURES TO TRANSITION TO SUSTAINABLE ENERGY FUTURE

California can transition to an efficient and sustainable transportation energy system that reduces our petroleum dependence and reduces our contribution to greenhouse gas emissions. The state can achieve a goal of reducing demand for petroleum fuel to 15 percent below 2003 levels by 2020 while continuing to meet the demand for transportation services.

SUSTAINABLE TRANSPORTATION ENERGY SYSTEM

Continued reliance on petroleum-based fuels poses risks for the economic and environmental health of California. With in-state refineries operating at near capacity, efforts are needed to improve near-term supply responsiveness when refineries experience unplanned outages. Over the long-term, the state should work to reduce demand for petroleum and shift to a more sustainable transportation energy system. Options to address our fragile supply and demand condition include both increasing supply of non-petroleum fuels, as well as lessening fuel demand. Although these solutions are mid- to long-term, action should be taken now to avoid the adverse consequences related to California's heavy reliance on petroleum.

From the mid-1970s through the late1980s, significant gains in the fuel economy of passenger vehicles were made, primarily to meet federally mandated corporate average fuel economy (CAFE) standards. Since then, CAFE standards have remained virtually unchanged and technology advancements for passenger vehicles have been employed primarily to improve safety, performance, and comfort, rather than boosting fuel economy.[27]

While passenger vehicle fuel economy has remained relatively flat in the last two decades, California's petroleum demand has risen substantially. This trend has been primarily due to three factors: increasing miles traveled per vehicle, a rising state population, and growth in the sales of less fuel-efficient vehicles, including sport utility vehicles (SUVs) and other light trucks.

Other potentially significant trends may allow for higher passenger vehicle fuel economy. For example, gasoline hybrid electric vehicles and light-duty diesel vehicles offer efficiencies much higher than conventional gasoline vehicles. In addition, future state actions to address global climate change and greenhouse gas emissions could lead to reductions in the demand for petroleum fuels in the transportation sector.

To reduce California's dependence on petroleum, measures must be adopted to improve transportation efficiency and expand the use of non-petroleum fuels. Just as the state's substantial demand for petroleum products is the result of many factors that have occurred over a long period of time, efforts to reduce petroleum consumption will require implementation of a suite of options over the long term. While there are steps that the government can take in the near term, the most effective strategies to reduce demand for petroleum require long lead times to fully implement.

Several options exist to ease California's growing demand for transportation fuels:

1. Increase fuel efficiency of existing vehicles
2. Increase fuel efficiency of new vehicles
3. Fuel substitution options
4. Pricing options
5. Other options

The measures considered here can be part of a "portfolio approach," a method of pursuing a suite of options to hedge against supply concerns and volatile fuel prices. Over time, these and other options can be applied to help ensure California's transportation system remains secure, cost effective and environmentally benign.

COSTS AND BENEFITS EVALUATION OF MEASURES TO REDUCE PETROLEUM DEPENDENCE

Petroleum Dependence Reduction Measures

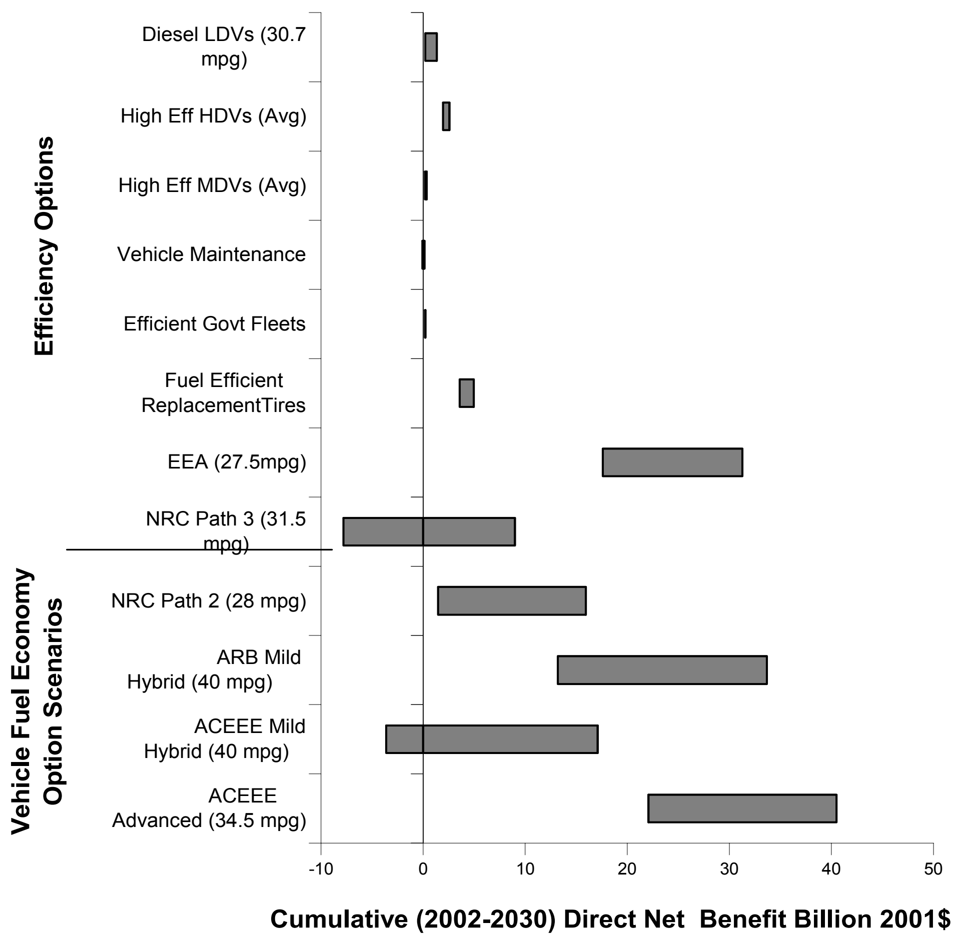
The Energy Commission and the California Air Resources Board (CARB) recently completed a report titled: ***Reducing California's Petroleum Dependence*** in response to Assembly Bill 2076 (Chapter 936, Statutes of 2000; Shelley). In part, this legislation directed the Energy Commission and CARB to develop and adopt recommendations for the Governor and the Legislature on a strategy to reduce California's petroleum dependence. As part of this effort, petroleum reduction options were evaluated based on a comparative cost and benefit methodology. This work, which includes estimates of the net benefits to the state from various transportation options, considered consumer and economic costs, environmental benefits, and the external costs of petroleum dependence.

Based on the analysis conducted for the AB 2076 report, **Figures 7.1 and 7.2** show the estimated range of direct net benefits (in billions of 2001 dollars) for California during the time period 2002 to 2030 for most of the options considered. Direct net benefits include the impacts on consumers, the environment, and energy security.

Analyses for the fuel efficiency options, in general, assumed 100 percent penetration of various fuel economy technologies for new vehicles. In contrast, analyses for most of the fuel substitution options were based on a fixed market penetration level during the time period in an effort to provide reasonable fuel-by-fuel comparison.

These assumptions are not intended to be forecast estimates of fuel use or technology acceptance. Assumptions were made to estimate the potential advancements with technologies, with the general assumption that the greatest advancements would be made with emerging technologies.

Figure 7.1
Direct Net Benefit of
Selected Fuel Efficiency Options and Scenarios



* Vehicle Fuel Economy Option Scenarios are based upon 100% market penetration by 2014; others vary.

Improvements in Vehicle Fuel Efficiency

Several methods can be employed to improve the fuel efficiency of new and existing vehicles. Listed below are highlighted options analyzed by staff.

Fuel Efficient Tires and Proper Tire Inflation

Research has shown that a vehicle's fuel economy can increase or decrease depending on the rolling resistance of its tires. The potential fuel economy improvement from low rolling resistance tires is approximately three percent compared to tires with average rolling resistance. While low rolling resistance tires can provide important and cost effective fuel savings, little information is available on fuel efficiency of various replacement tires, both to researchers outside the tire industry and consumers. As a result, more information must first be collected and analyzed on rolling resistance before the full efficiency benefits can be determined. Once this is completed, an outreach program to disseminate this information to consumers could provide significant fuel savings.

According to the Rubber Manufacturers Association, a typical passenger vehicle will suffer an approximately one percent reduction in fuel efficiency from under-inflated tires.[28] When tires are grossly under inflated, fuel economy can be reduced by several percentage points. Numerous studies have shown that when tires are under-inflated, vehicle safety is impaired and tire wear is increased. A consumer outreach program, designed to inform and encourage consumers to maintain proper tire pressure, could provide substantial savings of fuel over time.

Improved Vehicle Maintenance

This option would initiate a state campaign to educate motorists on the benefits of improved maintenance practices as a way of reducing gasoline consumption. Improving the efficiency of California's vehicle population through better maintenance can be achieved immediately since it does not require technology advancement. Better vehicle maintenance may include periodic engine tune-ups, improved engine lubrication, changes of air and oil filters, and other maintenance measures. The U.S. Department of Energy (DOE) estimates that failure to perform periodic maintenance practices can reduce individual vehicle fuel economy by 1 to 10 percent in the case of air filter changes and by 1 to 2 percent in the case of oil and oil filter changes.

Efficient Government Light-Duty Fleets

This petroleum reduction option would direct government fleet vehicles in California to use more fuel efficient vehicles or vehicles that use non-petroleum fuels. Under this option, local, state, and federal fleets would select the most fuel-efficient vehicle in each class for their vehicle purchases whenever service requirements can be safely satisfied. Currently, there are about 231,000 light-duty vehicles in government fleets in California; approximately 41,000 of those are in the state's fleet.[29] Analysis shows approximately seven million gallons of petroleum could be reduced each year from implementing this option.

Efficient Diesel

Currently produced light-duty diesel vehicles are typically 30-60 percent more fuel efficient[30] than comparable gasoline vehicles. Therefore, an increased sales penetration by these vehicles could reduce petroleum use in the state. National requirements for improved diesel fuel formulations that lower sulfur levels to 15 ppm in late-2006 and further development of emission control systems tailored to diesel engines may allow greater use of light-duty diesel vehicles in the U.S. While manufacturers have not yet fully demonstrated that they can build cost-competitive diesel cars and light-duty trucks that meet California's emission standards, the potential exists for diesel passenger vehicles to significantly penetrate the light-duty vehicle fleet in the next decade and beyond.

The vast majority of heavy-duty trucks and buses run on diesel, as do a significant portion of medium-duty vehicles. The potential exists to boost medium- and heavy-duty diesel fuel efficiency through research, development, and demonstration (RD&D) programs, such as the U.S. DOE's 21st Century Truck Program, a government and private industry collaborative.

Truck and bus fuel economy gains used as an upper bound in the AB 2076 analysis are based on the 21st Century Truck Program goal of doubling fuel economy. The technology improvements explored in this effort include better combustion technology, reductions in vehicle weight, the use of hybrid and auxiliary power technologies, aerodynamic improvements, and rolling and inertia resistance improvements.[31]

Hybrid Electric Vehicles

The introduction of gasoline-electric hybrid vehicles (hybrids) in the late 1990s marked the beginning of a significant change in vehicle platforms and the potential to provide important fuel economy improvements. Hybrid vehicles commercially available today utilize both a small internal combustion (ICE) gasoline engine and a bank of batteries to maximize fuel economy, while producing very low tailpipe emissions.

While only three models of commercial hybrids have been introduced to date, several automakers have announced plans for additional models in the next few years. Furthermore, some manufacturers see this technology becoming mainstream in a few years, and may be found in most light-duty models.

> (Toyota)…executives pledged that Toyota's hybrid technology will work its way into almost every Toyota and Lexus nameplate in the near future, either as a fuel-economy measure or for higher performance.[32]

Hybrid vehicles can be designed in various configurations, including mild or full-hybrids, which are distinguished by the amount of power provided by electricity. While not available commercially, "grid connected" or plug-in hybrids combine the ability to provide limited range all-electric driving and traditional gasoline/electric hybrid power generation.

Increasing Fuel Economy Standards

According to some national experts, such as the National Research Council of the National Academy of Sciences and the American Council for an Energy Efficient Economy, multiple pathways exist to achieve an on-road fleet average fuel economy of 30 to 45 miles per gallon (mpg). The Corporate Average Fuel Economy (CAFE) standards, set by the federal government beginning in 1977 and virtually unchanged since 1985, require a fleet average of 20.7 mpg for light-duty trucks and 27.5 mpg for passenger cars. Thus, there appears to be a significant opportunity to reduce petroleum fuel consumption by increasing the fuel economy of light-duty vehicles.

In most of the fuel economy scenarios evaluated in the AB 2076 report, increasing vehicle fuel economy provides consumer fuel savings that exceed the increased cost of the more fuel-efficient vehicle.[33] A combination of technology options available to automakers could yield a doubling of average fuel economy to approximately 40 mpg in a cost-effective manner.

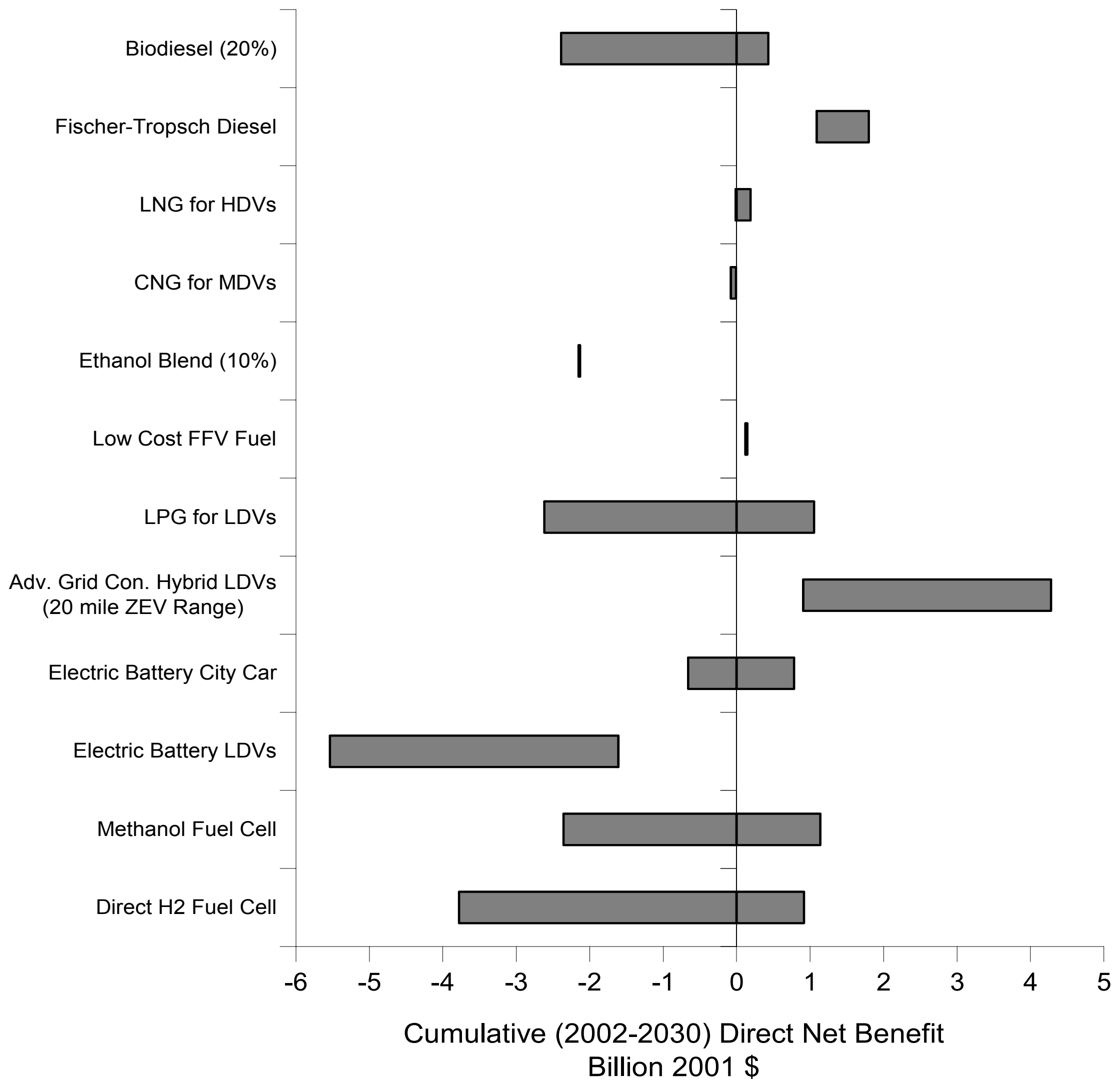
The technologies examined for achieving fuel economy improvement in the AB 2076 report have in general been sufficiently developed to warrant their consideration for widespread application. These technologies include improved aerodynamics, increased use of low rolling resistance tires, integrated starter-generators with 42 volt electrical systems, continuously variable transmissions, and hybrid-electric designs. Engine efficiency improvements through variable valve timing, cylinder deactivation, and direct injection fuel systems can also be employed utilizing technology that is now available.

Fuel Substitutions/Alternative Fuels

In addition to demand reduction options such as improved efficiency, supply-side options are available. This would include expanded use of cleaner burning, non-petroleum fuels, often referred to as alternative fuels.

Since the late 1970s, the state has investigated and promoted the use of non- petroleum fuels. Penetration of these fuels into the California market has been limited, and their usage continues to be small compared to petroleum-based fuels. Furthermore, while gasoline and diesel are readily available throughout the state, the availability of non-petroleum fuels is much more limited. Below is a summary of the status and availability of several advanced technologies and alternative fuels. **Figure 7.2** illustrates the estimated direct net benefits of several of these highlighted petroleum substitution options that were analyzed as part of the AB 2076 report.

Figure 7-2
Direct Net Benefit of
Selected Fuel Substitution Options



Ethanol

With the phase out of methyl tertiary-butyl ether (MTBE) in California's gasoline supply, ethanol has become the replacement oxygenate of choice. Gasoline is now being blended with 5.7 percent ethanol by volume. Well in excess of 100 million gallons of ethanol are expected to be used annually.

Ethanol can also be used in flexible fuel vehicles (FFVs) that can operate on a mixture of up to 85 percent ethanol and 15 percent gasoline, called E85. Approximately 178,000 ethanol FFVs are operating on gasoline in California. However, with no E85 available in the state, these vehicles are operating on gasoline only.

Ethanol production in the U.S. is primarily derived from corn, making it a renewable fuel. Not surprisingly, the majority of E85 stations are in the Midwest, the nation's primary corn growing region. While there have been proposals to provide E85 in California, no stations have been established. At least one project to install an E85 station in the state is now being developed and a few more projects are being proposed, but expansion of E85 stations beyond these few is unclear at this time.

Methanol

Automobile manufacturers have also produced FFVs designed to operate on M85, a blend of 85 percent methanol and 15 percent gasoline. Several thousand of these vehicles were commercially introduced in California between 1992 and 1998. However, the use of M85 was discontinued after the last of the agreements expired between fueling stations and the state. The fuel is no longer distributed in California. At its peak, there were approximately 100 stations dispensing M85 in the state.

Methanol is often described as an excellent "hydrogen carrier" and is being used as a demonstration fuel for a few prototype fuel cell vehicles (FCVs). Indirect methanol FCVs use a reformer to extract hydrogen from pure methanol. Analysis conducted by staff as part of the AB 2076 report only considered a scenario where methanol would be used in FCVs (Figure 7.2). One methanol FCV is known to have been demonstrated in California. A methanol station in West Sacramento provides fuel for methanol fuel cell vehicles located at the California Fuel Cell Partnership's facility. Staff is not aware of plans to add methanol stations in the state and its future market acceptance remains unclear.

Fischer-Tropsch Diesel

Fischer-Tropsch (FT) diesel is a synthetic fuel made from natural gas, but can also be produced from coal or biomass feedstocks. The FT process can be used to make a variety of synthetic fuels, including gasoline and alcohols. FT diesel can be used either alone or blended with conventional diesel and does not require modification to conventional compression ignition (diesel) engines or existing fueling infrastructure. Because pure FT has a high cetane number, low aromatic content, and has no sulfur, it is attractive for blending with conventional diesel.

Although no significant amount of FT diesel is currently being used in California, the CARB requirement for ultra-low sulfur diesel beginning in late 2006 may increase its use in the near future.

Biodiesel

Biodiesel, a renewable fuel made from esterified vegetable oils, can be a pure fuel or blended with diesel in any percentage and used in compression ignition engines.[34] Little or no modification to an engine is required with biodiesel/diesel blends.

Approximately four million gallons of biodiesel were consumed in California during 2002.[35] Like many other non-petroleum fuels, biodiesel qualifies as an alternative fuel under the Energy Policy Act (EPAct), which is one of the key motivating factors for its use. Biodiesel use has grown in recent years and the City of Berkeley announced in June 2003, that it is converting its fleet of almost 200 diesel vehicles to operate on 100 percent biodiesel (B100).

Natural Gas

Natural gas continues to be used as a transportation fuel in both California and nationwide. A variety of natural gas vehicles (NGVs) are now commercially available. NGVs have emerged in recent years in virtually all on-road applications, including transit buses, school buses, refuse haulers, vans, and passenger cars.[36]

Both compressed and liquefied natural gas stations can be found throughout much of the state. Natural gas can be used in both spark ignited and compression ignition engines. Many of the light-duty natural gas vehicles are produced as bi-fuel vehicles, which can be operated on either natural gas or gasoline. At the present, California has approximately 16,000 light-duty and 4,000 heavy-duty vehicles that can operate on natural gas.[37]

Liquefied natural gas (LNG) is used for heavy-duty vehicle applications in the state and is preferred in some applications because of its ability to provide greater energy on board a vehicle compared to compressed gas. This is especially critical for large commercial trucks. In 2001, an estimated 575 heavy-duty LNG vehicles were operating or under immediate procurement in California.[38]

As of early 2003, there were 206 compressed natural gas (CNG) stations, 81 of which offered full or partial access for the public. Some small home/office refueling devices are used in addition to these numbers. Approximately 30,000 vehicles are operating on CNG in the state. More than 25 LNG stations were operational or under construction in California.[39] Some LNG stations have been designed to dispense CNG as well.

LPG

Liquefied Petroleum Gas (LPG), or propane, continues to be used as a transportation fuel. Like natural gas vehicles, LPG vehicles are generally produced as bi-fuel designs, allowing the operator to run on LPG or gasoline. Staff believes that LPG vehicles operating in the state number in the thousands. As in recent years, only a few vehicle models have been available for sale in California.

Approximately 1200 LPG stations can be found in California. However, the majority are used for purposes other than transportation, with only about 3 percent of these stations providing fuel for vehicles.[40]

Electricity

California has been a leader in the use of electric vehicles (EVs) primarily because of the zero emission vehicle (ZEV) regulation adopted by CARB. Originally drafted in 1990, CARB has made periodic modifications to their ZEV rule, including recent changes made in

April 2003. These changes provide the automakers greater flexibility in meeting the ZEV rule and now include options to use ultra low emission technologies and an option to produce hydrogen fuel cell vehicles or battery EVs.

The number of EVs operating in California has decreased in recent years. As of mid 2003, the number of EVs in California is estimated at a few thousand, including neighborhood electric vehicles (NEV). With the current market and regulatory environment, it is doubtful whether battery EVs will achieve widespread use.

While the current market and regulatory environment makes successful penetration of EVs uncertain, NEVs continue to be sold in the state and now substantially outnumber full-size, passenger EVs. Unlike full-size EVs, which generally recharge at high voltage, NEVs are often charged at home or at work using conventional 110 volt electrical outlets and are restricted from highway use.

Hydrogen

While significant resources are being devoted to hydrogen fuel cell vehicles by most automakers and technology advancements have been encouraging, substantial barriers exist before a commercially viable product can be produced. Automakers now demonstrating FCVs have predominately chosen hydrogen as their fuel of choice, negating the need for an integrated on-board reformer in the near-term. Hydrogen used in internal combustion engines is also being demonstrated by some automakers.

Given the interest on the part of automotive manufacturers, the deployment of hydrogen fueling stations is also a growing consideration. Hydrogen infrastructure will likely be limited in the near term by high capital investment costs, as well as the very limited number of demonstration vehicles that will be available to use the fuel in the next few years.

Table 7.1 summarizes the status and availability of various clean-burning fuels and their use in California.

Table 7.1
Clean Burning Fuel Use in California, 2002

Fuel Type/ Technology	Estimated Use, Million Gallons/Year (gasoline gallon equivalent)	Estimated Number of Stations in California	Estimated Number of Vehicles in California
Ethanol/FFVs (E85)	0	0	178,000
Methanol/FFVs (M85)	0	0	5,600
Methanol/Demonstration Fuel Cell Vehicle (M100)	NA	1	1
Fischer-Tropsch Diesel	NA	0	NA
Biodiesel	4.3[(1)]	NA	NA
Compressed Natural Gas	41.0[(2)]	206	20,000
Liquefied Natural Gas	6.5[(3)]	25	575
Liquefied Petroleum Gas	NA	35	2,400[(4)]
Electricity, (Including neighborhood vehicles)	1.7[(5)]	Hundreds	12,500
Hydrogen/Demonstration Fuel Cell Vehicles	NA	8	30

(1) Based on 4 million actual gallons, California Energy Commission memo, Scott Hughes, National Biodiesel Board; assumes 120,000btu/gallon
(2) Based on 46 million therms; CEC, *Reducing California's Petroleum Dependence*; *Appendix B*, 2003
(3) Based on 10 million gallons of LNG, Jon Leonard, Personal communication, TIAX, LLC
(4) Gary Occhiuzzo, California Energy Commission
(5) Year 2000, based on 540 million kWhr; CEC, *Reducing California's Petroleum Dependence*; *Appendix B*, 2003

Pricing Options

Pricing strategies can also be used to reduce California's petroleum dependence. The pricing options shown below could contribute to reduced gasoline use through their effect on consumer behavior. However, based on staff analysis, some of the pricing options did not yield positive net benefits for consumers while the remaining pricing options were judged to be politically impractical.

- Gasoline Tax
- "Pay at the Pump"
- "Pay as you Drive"
- Tax on Vehicle Miles Traveled
- Feebates
- Registration Fee Transfer
- Purchase Incentives

Table 7.2
Description of Pricing Options Evaluated

Option	Description
Gasoline Tax	Raise California gasoline tax by \$0.50 per gallon.
Marginal Pricing for Auto Insurance "Pay at the Pump"	A portion of motorists automobile insurance would be paid through a fuel surcharge.
Marginal Pricing for Auto Insurance "Pay as you Drive"	A portion of automobile insurance would be paid through a per-mile charge.
Tax on Vehicle Miles Traveled	A tax on VMT in California of 2 cents per mile.
Feebates	Purchasers of new vehicles either receive a rebate if they buy vehicles emitting relatively low levels of carbon[a] or pay a fee if they buy a vehicle that emits relatively high levels of carbon. Each year, value of total fees would be equal to value of total rebates.
Registration Fee Transfer	A portion of annual auto registration fees would be paid through a fuel surcharge.
Purchase Incentives	Government provides a purchase incentive for the most fuel-efficient vehicle in each class at the time of sale.

(a) Carbon or CO_2 emissions are directly proportional to vehicle fuel economy.

Other Options

Other options to reduce petroleum use that were explored, but not extensively analyzed include:

- Expanded use of public transit
- Land Use Planning
- Telecommuting
- Reducing speed limits
- Voluntary Accelerated Vehicle Retirement
- Ridesharing

While these options also show potential for reducing fuel consumption, it is not well understood how effective they would be and their costs are generally site specific. Since the petroleum fuel displacement for these options appears to be less than or equal to the displacement in cases that could be much better quantified, staff conducted only limited research.

Petroleum Dependence Reduction Goals and Implementation Measures

The petroleum reduction options discussed above, when combined in a cost-effective portfolio, can result in significant fuel savings and provide the basis for goals that California can achieve. Through analysis and a series of public workshops, the Energy Commission and the CARB adopted the following goals:

1) Reduce the state's energy consumption of on-road gasoline and diesel to 15 percent below the 2003 demand level by 2020.
2) Double the on-road fuel economy standards of new cars and light-trucks.
3) Increase the use of non-petroleum fuels to 20 percent of total on-road energy demand by 2020 and 30 percent by 2030.

The gasoline and diesel reduction goal for 2020 would serve as an upper limit for gasoline and diesel fuel demand for the foreseeable future. While ambitious, these goals were found to be technically feasible and cost effective with a combination of existing technologies, the use of non-petroleum fuels and further development of pre-commercial advanced technologies and fuels.

The strategy is based on implementing feasible and economic options that reduce petroleum usage and provide net benefits to society. Because some of these options compete in the same market, estimates of their individual petroleum displacements would not necessarily be additive in a portfolio. Therefore, all of the options were not used simultaneously in the process of trying to develop a fuel reduction goal.

Nearly all of the fuel efficiency options show positive direct net benefits. This analysis is sensitive to the estimated future cost of fuel and technologies, but under the cost assumptions that were made, the increased purchase price of a new, higher efficiency car or truck was typically more than offset by the lifetime fuel savings. For the fuel substitution options, a few showed positive direct net benefits, while several did not. Net benefits for these options would increase if diesel and gasoline prices are higher in the future than the levels assumed in the analysis.

The transition strategy begins in the near-term with California's gasoline and diesel demand peaking by 2010. Continuing in the mid-term, additional demand measures are implemented to reduce fuel demand to 15 percent below 2003 levels. Finally, in the long-term, the state's demand for gasoline and diesel is maintained at 15 percent below 2003 levels. The following description is an example scenario of options that could be combined to successfully achieve the petroleum reduction goal. Other combinations could emerge as technologies mature and the private sector innovates to find the optimum (lowest cost) pathway.

To implement the goals, it is helpful to view them in the logical timeframe when they can be executed: near-, mid- and long-term. Near-term is for options that could be fully implemented by 2010; mid-term is for 2010 to 2020; and long-term is for 2020 to 2030.

Near-Term
- Use more fuel efficient replacement tires with outreach campaign for proper tire inflation.
- Improve fuel economy in government fleets.
- Improve private vehicle maintenance.

Mid-Term
- Double the fuel efficiency of new light duty vehicles to 40 miles per gallon.
- Use natural gas-derived FT diesel as a 33 percent blending agent in diesel.
- Expanded use of ethanol, LNG, CNG and grid-connected hybrids among others.

Long-Term
- Introduce fuel cell light-duty vehicles in 2012, increasing to ten percent of new vehicle sales by 2020, and 20 percent by 2030.

These goals were developed to keep California's transportation sector, and the broader economy upon which it depends, robust, competitive, and environmentally sustainable. It is an aggressive petroleum reduction strategy that is technically and economically feasible using a combination of existing as well as emerging technologies.

EXAMINATION OF POTENTIAL EFFECTS OF VEHICLE EFFICIENCY IMPROVEMENTS AND NON-PETROLEUM FUELS USAGE

Public Health and Safety

The analysis conducted for the AB 2076 report shows an overall reduction in environmental impacts from vehicle efficiency improvements and non-petroleum fuels usage. By lowering petroleum fuel demand, the damage caused to public health by reducing pollution will also be reduced. This result comes from the avoidance of released pollutants from fuel production and combustion, petroleum related spills, water pollution from fuel spills and urban run off, soil contamination and by lowering the potential impacts of climate change.

The damages to humans resulting from exposure to pollutants include adverse affects to health (morbidity), including emphysema, asthma, eye irritation, headaches, etc., and increased mortality risk.[41]

The Economy

The use of high efficiency vehicles and non-petroleum fuels will provide benefits to the economy. However, some sectors of the economy, mainly the petroleum industry, would be negatively impacted by a petroleum reduction strategy. Increased fuel efficiency would reduce the demand for refined petroleum products. In addition, decreased petroleum sector output would adversely affect upstream crude oil suppliers.

On the other hand, California's economy would benefit from savings realized from the reduction of health related costs from avoided pollution. In addition, consumers and many businesses in the state will benefit if the implementation of petroleum reduction goals results in lower fuel expenditures. Money freed from fuel expenditure requirements would be spent on other products such as food and apparel.[42]

The government would also feel the impact of reduced demand for petroleum. Savings to the government could be realized from avoided clean up costs of petroleum fuels related spills and contamination and other forms of pollution. However, potentially more significant is the loss of tax revenue due to reduced collection of excise taxes on petroleum fuels. Even if petroleum use is simply replaced by alternative fuels, tax revenues may be reduced since tax rates on non-petroleum fuels is in some cases, and may continue to be, lower than for petroleum-based fuels.

Resources

The potential impacts on California's resources as a result of reduced petroleum use have not been extensively examined. The potential impact on natural gas supply caused by an increase in natural gas vehicles could affect already tight supplies of this increasingly important fuel. Natural gas is also a feedstock for other fuels, including FT diesel, other gas-to-liquids fuels, and hydrogen, so gas markets may be impacted by the use of these fuels. These possibilities warrant monitoring and further evaluation.

Environment

Reducing petroleum consumption has the potential to provide air quality benefits, whether the reduction comes from increased fuel efficiency or from fuel substitution. While improved fuel efficiency does not directly reduce criteria pollutants, a beneficial impact is realized because of reductions in upstream emissions. For example, reduced petroleum consumption results in lower emissions at refineries, fewer trips from tanker trucks, trains, and ships transporting fuel, and lower evaporative emissions from refueling.

Substituting petroleum fuels with alternative fuels can have a beneficial impact on tailpipe emissions. However, life cycle emissions resulting from the use of alternative fuels and technologies depend on many factors, including vehicle emission control technology, feedstock type, and fuel production process. For example, the electricity used to recharge an electric vehicle could come from sources that produce no emissions (i.e., hydroelectric, solar) or substantial emissions (i.e., older gas-fired plant). This is also true for other fuels, such as hydrogen and ethanol.

The greatest potential for reducing life-cycle emissions from a given vehicle comes from battery electric and direct hydrogen fuel cell technologies, since they produce no tailpipe or evaporative emissions. Ultimately, the lowest life cycle emissions result from combining zero emission technologies and a renewable fuel (i.e., solar, wind, etc.). While this environmentally preferred scenario is available today, high costs will continue to limit its widespread acceptance in the near term.

Criteria pollutants, including carbon monoxide (CO), volatile organic compounds (VOC), oxides of nitrogen (NOx) and others can also be reduced from lowering petroleum demand. According to the analysis for the AB 2076 report, reducing a gallon of gasoline consumption results in the reduction of approximately 1.1 grams of criteria pollutants from both the vehicle and fuel cycle.[43]

The use of non-petroleum fuels and more fuel efficient vehicles also have the potential to reduce greenhouse gases (GHG). Although the potential impacts of climate change are wide-ranging, California has reason to be particularly concerned about coastal impacts, due to rising sea levels and altered precipitation patterns that could change the timing and relative amounts of rain and snowfall in the Sierra Nevada Mountains.[44] Reducing gasoline consumption by one gallon results in the reduction of approximately 11 kilograms of greenhouse gas emissions, taking into account both vehicle and fuel cycles.[45]

Energy Security

While debate continues as to the sufficiency of world oil supplies in the longer term, experts conclude that world oil supplies will gradually decline, with domestic supplies decreasing long before those in the Middle East. In addition to the likelihood of higher oil prices, this will result in even greater reliance on foreign sources of petroleum, an energy security risk for California and also for the nation as a whole.[46]

Lowering the state's demand for petroleum offers potentially significant energy security benefits. The use of non-petroleum fuels would diversify our transportation fuel mix, leaving the state less vulnerable to external petroleum supply shocks.

NEED FOR CONTINUED ANALYSIS AND RESEARCH, DEVELOPMENT AND DEMONSTRATION

While the AB 2076 work suggests that petroleum use can be reduced significantly by strategies that provide net benefits to the state, the analysis is subject to many uncertainties. Such uncertainties include (among others) the costs and effectiveness of new vehicle technologies, the value to the state of reduced environmental damages, particularly reduced greenhouse gas emissions, the impact of higher fuel efficiency on vehicle safety and consumer choice, and the impact of higher fuel efficiency on driving patterns. Further investigation of these uncertainties must continue to ensure that California makes the transition to a more efficient and sustainable transportation energy system in the most cost-effective manner possible.

The Energy Commission staff also believes it is critical to invest in transportation technology advancement. Investments in technology to reduce future demand for fuels can produce overall net economic, environmental, and energy security benefits. While commercially available technologies exist to help California attain much of the proposed performance and cost improvements, significant additional work is needed with emerging transportation technology options that can only be achieved through additional research development and demonstration (RD&D) activities.

Technologies selected for evaluation under the AB 2076 report include promising options to improve fuel efficiency and increase the use of non-petroleum fuels. These options can benefit from additional investment in RD&D. Some have found successful use in niche applications, such as compressed natural gas and liquefied natural gas in bus and truck fleets or other high usage applications. Hybrid electric technologies appear to be emerging rapidly, spurred by initial consumer interest in a limited number of models offered by manufacturers. Others, such as hydrogen fuel cells, require significant development and performance breakthroughs before a commercial opportunity can be assured. Nevertheless, if RD&D goals being pursued for these options are successfully achieved, these longer term technologies can have widespread commercial application.

Technical and market barriers related to these technology options should be priorities for consideration in state RD&D activities. Although, these options are at different levels of maturity, the Energy Commission clearly has an opportunity to play a lead role in the resolution of infrastructure barriers facing non-petroleum fuels. The Energy Commission can coordinate with government fleets to acquire and demonstrate non-petroleum fueled vehicles and advanced technologies with improved efficiency. Analytically, the Energy Commission can evaluate market barriers faced by manufacturers who may be reluctant to invest in greater vehicle efficiency and support the study of consumer choice and behavior to better focus information campaigns for more efficient vehicles.

According to the AB 2076 analysis, improving new vehicle fuel economy produces both the largest net benefits and the largest displacement of petroleum fuel. While important fuel economy gains can be achieved with application of existing technologies, the recommended doubling of new vehicle fuel economy, for example, requires successful attainment of various RD&D goals. The likely success of these options will be greatly improved through research and analysis on a variety of factors that influence manufacturer investment decisions on fuel efficiency, performance, design impacts on safety, and consumer choice.

Continuing RD&D for other fuel substitution options that were not projected to provide positive direct net benefits in the AB 2076 analysis may improve their standing compared to existing petroleum fuel technologies and lead to increased use in niche applications. RD&D activities for the fuel substitution options include work to improve end-use performance, as well as to improve fuel production performance and infrastructure deployment.

Public Interest RD&D

Industry interests can conflict with public welfare, such as in the case of vehicle efficiency improvement. The automobile industry has claimed that investing limited RD&D dollars to develop new technologies that may improve efficiency will not be profitable if high efficiency vehicles remain less popular with car buyers. Within the petroleum industry, supporting RD&D for higher vehicle efficiency results in lower product sales and becomes a powerful financial and strategic disincentive. These and other examples of private sector reluctance to pursue public benefits underscore the need for public resources to support targeted transportation RD&D. Public interest RD&D for transportation should focus on areas the private sector perceives to produce insufficient financial gain. These areas include:

- Improving energy diversity and energy security,
- Improving engine and overall vehicle fuel efficiency,
- Reducing emissions of criteria pollutants beyond regulated levels,
- Developing sustainable fuels that are derived from renewable resources,
- Developing low carbon fuels and technologies with low life cycle emissions of greenhouse gases.

Investment is also needed to develop fueling infrastructure for non-petroleum fuels where industry investment is perceived to be too risky or return on investment is insufficient. Whereas today's petroleum industry includes several very large, well capitalized companies with multi-million dollar research and development (R&D) budgets, industry leaders developing non-petroleum transportation fuels often lack the resources required to develop fueling infrastructure. Where this occurs, government RD&D support and resources is needed.

An example of one area of need within transportation RD&D is the advancement of fueling infrastructure, particularly for emerging fuels such as hydrogen. As technical barriers and cost reductions are being addressed for hydrogen fuel cell technology and related integration with vehicle systems, an equally important research and development arena involves issues of production and distribution of hydrogen, resource feedstocks, and possible integration of mobile fuel cells with stationary energy systems. These latter subjects, bundled under the general heading of hydrogen infrastructure and pathways, focus on making the possible transition from conventional petroleum fuel technologies to a hydrogen-based system.

The attractiveness of hydrogen as a source of energy is linked to its fuel cycle benefits and sustainable qualities. However, the existing transportation marketplace does not favor products with this emphasis or these attributes. Thus, potential market success for hydrogen fuel cell vehicles may depend upon a new consumer perspective. This perspective would recognize that the choice of hydrogen feedstock, producing, and delivering hydrogen, and fuel cell multi-use are also valued attributes because these elements are part of the fuel cycle.

R&D on hydrogen infrastructure and pathways and pilot demonstrations of leading candidate systems are important steps in the successful deployment of fuel cell technology. Determining the preferred mix of attributes that lead to the lowest direct consumer expense (i.e., lowest cost vehicle and operating cost combination) or best net benefit (includes societal and energy security benefits) will be necessary to commercialize hydrogen fuel cell vehicles. Other fuels, including LNG, LPG, ethanol and others, stand to benefit from RD&D spending in an effort to explore and develop ways to reduce infrastructure capital requirements, and maintenance and operating expenses.

State Government Role

The Energy Commission's influence on the direction of on-going transportation RD&D activities and on the potential success in developing technologies to meet California's needs depends on the state's ability to contribute resources to these efforts. While meaningful analysis can be performed internally with staff resources, critically important aspects of technology advancement includes conducting laboratory work and building tangible developmental products. Energy Commission staff lack the R&D facilities and development engineering resources to conduct such work.

Proof-of-concept hardware development, deployment of infrastructure, and field demonstrations require monetary contributions for implementation, especially when the desired performance targets may require additional effort or investment to allow for application in California.

California's Transportation RD&D Background

Historically, the Energy Commission has provided resources to advance transportation RD&D, including support for the development of methanol-fueled vehicles, ethanol production plants and various programs that supported a wide variety of alternative fuel vehicle projects. In particular, the Transportation Energy Technology Advancement Program (TETAP), through annual competitive solicitations, provided several million dollars match share to a variety of advanced transportation projects in the 1990s.

Recent transportation RD&D at the Energy Commission includes the following activities:

- The Energy Commission is supporting the development of small-scale liquefied natural gas (LNG) production facilities for vehicle use. The goal of the projects funded to date is to demonstrate a variety of technologies and achieve cost targets.

- The Energy Commission is one of the partners supporting R&D for natural gas vehicle engines through the Next Generation Natural Gas Vehicle Program. This effort is working to develop advanced, commercially viable, medium- and heavy-duty NGVs that are energy efficient and ultra low emitting.

- The Energy Commission is working with federal agencies and programs on transportation issues in the past, such as DOE's State Energy Programs (SEP) grants and the Clean Cities program aimed at supporting a variety of clean, alternative fuel vehicle programs.

- The state is leveraging its resources by working with the DOE and industry on programs such as the FreedomCAR (Cooperative Automotive Research) Initiative.

This multi-year effort will advance fuel cell vehicle technologies and other efficient vehicle designs.

- The Energy Commission and the CARB are participants of the California Fuel Cell Partnership (CaFCP). The CaFCP is a public/private endeavor working to help commercialize fuel cell vehicles, with ongoing demonstrations of both passenger vehicles and transit buses that operate on fuel cells. Furthermore, the CaFCP is developing and demonstrating hydrogen and methanol fueling infrastructure critical for the use of fuel cell vehicles.

For approximately twenty years, the Energy Commission has primarily relied upon Petroleum Violation Escrow Account (PVEA) funds distributed by the federal government for transportation program expenditures aimed at reducing the demand for petroleum-based fuels. These funds have been used for both R&D efforts, as well as demonstrations of alternative fuel vehicles and fueling infrastructure. PVEA funds, however, are now largely exhausted and the resulting inconsistent mix and magnitude of current funding sources threaten the continuity of the state's transportation energy programs. Despite the importance of the Energy Commission's programs, funding levels for transportation energy programs has steadily declined and California is now losing its traditional leadership role in this arena.

While its contribution to RD&D has been comparatively modest compared with industry and the federal government, the state is in a unique position to focus resources toward specific programs and transportation systems that will provide the greatest internal benefits. Furthermore, California's role as the largest car and truck market in the country allows it to play a critical role in shaping transportation energy use.

It is paramount that the Energy Commission establishes a consistent and determinate funding source to make RD&D investments in transportation energy. Making direct monetary contributions to these development activities ensures that the state can capture the benefits of reduced reliance on petroleum fuels and greater transportation energy efficiency. Such efforts will influence industry investment decisions and shape the future of transportation in California. Ultimately, the development of advanced transportation technologies plays a vital role in a thriving economy and is inherently linked with conditions that protect public health and preserve the state's environment and natural resources.

CHAPTER 8: FINDINGS AND RECOMMENDATIONS TO STRENGTHEN THE TRANSPORTATION ENERGY INFRASTRUCTURE

In the Energy Commission staff's energy assessment of California's transportation energy sector, three major issues have been identified. They are:

1. Currently, California continues to be vulnerable to gasoline and diesel fuel price spikes that result from anticipated supply disruptions.

2. In the near term, California will experience higher and more volatile fuel prices if the transportation fuel industry cannot develop additional gasoline and diesel fuel to meet California's growing demand.

3. In the longer term, California needs to transition to an efficient and sustainable transportation system that reduces our dependence on petroleum and contribution to greenhouse gas emissions.

1. FUEL PRICE VOLATILITY

Due to California's petroleum industry's relative isolation and unique gasoline specifications, California susceptibility to price spikes is a result of unanticipated disruption in supplies. To remedy this situation, it is the state's marine infrastructure that is the primary entry point of the needed fuel supply that can help mitigate or dampen price spikes. The state has a role to ensure that unconstrained movement of imported gasoline and diesel supplies is adequate to meet the state's transportation fuel demands. To address California's current fuel price volatility issue, the Energy Commission staff recommendations are that:

- The Energy Commission will undertake a comprehensive evaluation of California's infrastructure needed to handle future petroleum product imports, in consultation with the following agencies – State Lands Commission, Ports of Los Angeles and Long Beach, Coastal Commission, and San Francisco Bay Conservation and Development Commission.

- The Governor and Legislature should identify a state licensing authority for petroleum infrastructure facilities.

2. INSUFFICIENT FUEL SUPPLY TO MEET NEAR-TERM DEMAND GROWTH

In the near-term, California's growing demand for transportation fuels will need to be met by significant increased levels of imports from foreign sources. If California's fuel demand cannot be met, California will experience higher and more volatile fuel prices. At this time, there is a lack of information to determine if sufficient supply additions are available or in planning. The Energy Commission staff recommendations are that:

- The Energy Commission should work with the transportation fuel industry to collect information on future expansion and construction plans for in-state refining capacity, importation of crude oil, blend stocks and finished products to assess future supply adequacy as well as constraints to expansion and construction that might adversely impact the delivery of future transportation fuel supplies.

In addition, the Energy Commission needs to determine the possible impacts of several ongoing legislative and regulatory proceedings on the quantity, price and quality of gasoline and diesel fuel needed to meet demand. These proceedings are:

– Federal Waiver to allow the use of non-oxygenated gasoline in certain areas of California. Without the waiver, California would need to use ethanol to comply with federal law, which would also impact supply of gasoline.

– Pending legislation in Congress to modify the Federal Energy Policy Act. If proposed legislation becomes law, all states would be required to meet a renewable fuel standard that specifies a renewable content in each gallon of gasoline. This requirement would potentially affect the price and supply of ethanol or other renewable fuels to California and the amount of gasoline necessary to meet California's growing demand.

.

– Reduced sulfur levels in diesel fuels throughout the U.S. Federal law requires that all states promulgate lower sulfur diesel fuel regulations by 2006. California has already promulgated similar diesel regulations. Refineries will need to make process modifications to meet the new diesel fuel specifications. In addition, as other states promulgate lower sulfur diesel fuel regulations, California will be affected in the price it pays for importing diesel fuel from other states.

To address any actions that come from these related proceedings, the Energy Commission staff recommendations are that:

- California should continue to pursue a California waiver from U.S. EPA's oxygenate requirements.

- The Energy Commission should continue to monitor the enactment and implementation of the pending federal Energy Policy Act legislation and its impact on California's transportation fuel price and supply.

- The Energy Commission should continue to monitor the progress of refineries to meet the CARB low sulfur diesel fuel regulation, as well as the progress of other states' implementation efforts.

3. TRANSITION TO A SUSTAINABLE TRANSPORTATION ENERGY SYSTEM

California's dependence on petroleum to meet its transportation energy needs will, in the long term, produce negative impacts. These negative impacts have economic, environmental and social costs that will reduce our competitive advantage, quality of life and economic well-being. California can effectively transition from petroleum dependence to an efficient and sustainable transportation energy system. The Energy Commission staff recommendations are that:

- The Governor and Legislature should adopt the recommended statewide goal of reducing demand for on-road gasoline and diesel to 15 percent below the 2003 demand level by 2020 and maintain that level for the foreseeable future.

- The Governor and Legislature should work with the California delegation and other states to establish national fuel economy standards that double the fuel efficiency of new cars, light trucks, and sport utility vehicles (SUVs).

- The Governor and Legislature should establish a goal to increase the use of non-petroleum fuels to 20 percent of on-road fuel consumption by 2020 and 30 percent by 2030.

There are two important areas that can provide support to meeting the long-term goal. These two areas that need to be addressed are:

- Research, development and demonstration and analytical activities are necessary and critical components to enable strategy options to compete in the marketplace.

- It is important that the world oil market can provide the necessary fuels in the interim, as California makes the transition from petroleum.

The Energy Commission staff recommendations are that:

- The Energy Commission should establish a working group of industry, environmental, and academic stakeholders to develop specific strategies to support research, development, and demonstration consistent with the recommendations adopted under AB 2076 (Chapter 936, Statutes of 2000; Shelley).

- The Energy Commission should continue to analyze the strategies identified in the AB 2076 report to improve its understanding of the costs and effectiveness of new vehicle technologies, the value to the state of reduced environmental damages, the impact of higher fuel efficiency on vehicle safety, consumer choices, and driving patterns.

- The Energy Commission staff should expand its analytical capability to evaluate the costs and benefits of fuel demand reduction options and deployment schemes, including: land use planning concepts, public transportation, and voluntary accelerated vehicle retirement.

- The Energy Commission, through public/private partnership collaboration, should pursue basic transportation energy research, hardware development, and infrastructure deployment.

- The Energy Commission should monitor world oil supply market to provide as much advance planning opportunity to respond to significant changes in the world oil production. Monitoring areas include: production profiles, especially for countries that may be nearing their production peaks, reserves to production ratios, industry and related financial markets, global oil substitution and demand reducing trends, and OPEC market share trends.

ACRONYMS

AB 2076	Assembly Bill 2076 (Chapter 936, Statutes of 2000)
ACEEE	American Council for an Energy Efficient Economy
B100	A transportation fuel that is 100 percent biodiesel.
B20	A mixture of 20 percent biodiesel and 80 percent diesel fuel.
Bbl	Barrel
Btus	British thermal units
CaFCP	California Fuel Cell Partnership
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CARB Diesel	Diesel fuel that meets the specifications set by the California Air Resources Board
CEQA	California Environmental Quality Act
CNG	Compressed Natural Gas
CO	Carbon monoxide
DOE	United States Department of Energy
E85	Alcohol fuel blend containing of 85 percent ethanol and 15 percent gasoline that can be used in specially designed flexible fuel vehicles.
EEA	Energy and Environmental Analysis, Inc.
EIA	Energy Information Administration
EPAct	Energy Policy Act
EV	Electric Vehicle
FCV	Fuel cell vehicle. A fuel cell is a device that through an electrochemical reaction converts fuel (hydrogen and oxygen) into electricity.
FFV	Flexible fuel vehicle. These vehicles are designed to operate on gasoline or a mixture of up to 85 percent alcohol (methanol or ethanol) and gasoline.
FreedomCAR Initiative	Cooperative Automotive Research Initiative. Sponsored by the U.S. Department of Energy
FT	FT Diesel – Fischer-Tropsch diesel. Fischer-Tropsch is a process of converting various feedstocks to fuels, such as natural gas converted to FT diesel.
GHG	Greenhouse Gases
H_2	Hydrogen
HDVs	Heavy-duty Vehicles
Hybrids	Gasoline-electric Hybrid Vehicles
ICE	Internal Combustion Engine
Jones Act	Fleets loaded at a U.S. port that sail to another U.S. destination must be shipped on a domestic flag vessel in accordance with federal law.

LDV	Light-duty Vehicle
LNG	Liquefied natural gas. At very cold temperatures, natural gas in its gaseous state, is converted into a liquid cryogenic fuel.
LPG	Liquefied Petroleum Gas
M100	100 percent methanol
M85	Alcohol fuel blend containing of 85 percent methanol and 15 percent gasoline that can be used in specially designed flexible fuel vehicles.
MBbl	Thousand barrel
Mbd	Million Barrels per Day
MDV	Medium-duty Vehicle
MMBbl	Million barrel
mpg	Miles per gallon
MTBE	Methyl tertiary-butyl ether (an oxygenate additive in gasoline)
NEV	Neighborhood Electric Vehicles
NGV	Natural gas vehicle
NRC	National Research Council
ppm	Parts per million
PRC	Public Resources Code
PSA	Permit Streamlining Act
PVEA	Petroleum Violation Escrow Account
R&D	Research and development
RD&D	Research, development, and demonstration
RFS	Renewable Fuel Standard
SEP	State Energy Programs
SFR	Strategic Fuels Reserve found in Assembly Bill 2076
SUV	Sport Utility Vehicles
TBD	Thousand barrel per day
TETAP	Transportation Energy Technology Advancement Program
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VMT	Vehicle Miles Traveled
NGV	Natural Gas Vehicles
VOC	Volatile Organic Compounds
ZEV	Zero Emission Vehicle

ENDNOTES

[1] California Energy Commission*, Reducing California's Petroleum Dependence*, Joint Agency Draft Report, July 2003, Publication # P600-03-005D
[2] Note that fuel cost per mile is equal to the price per unit of fuel divided by fuel efficiency (miles traveled per unit of fuel).
[3] Memo from California Energy Commission Staff, Chris Kavalec, 7/18/03. Note business establishments includes government fleets in the calculations.
[4] Based upon data from the Energy Information Administration, U.S. Department of Energy, *Fuel Oil and Kerosene Sales 1998*, Tables 23 and 24, Washington, D.C., August 1999.
[5] This assumption is consistent with the most recent Federal Aviation Administration forecast (source: *FAA Aerospace Forecast, Fiscal Years 2003-2014*, March 2003).
[6] The $25 per barrel oil price projection is a staff estimate based on analysis of historical oil prices and current market trends, surveys of other organizations' oil price forecasts, testimony received at Commission workshops, and assessment of OPEC oil marketing strategies.
[7] <http://www.energy.ca.gov/oil/statistics/crude_oil_receipts.html>
[8] Joseph Leto, Energy Analysts International, Presentation: "U.S. West Coast Petroleum Supply, Logistics and Economic Outlook" at California Energy Commission, Integrated Energy Policy Report -Transportation Fuels Workshop, July 11, 2003, Docket #02-IEP-01
[9] California Energy Commission, Petroleum Industry Information Reporting Act (PIIRA) Database
[10] California Energy Commission, *Supply Potential for Petroleum Products in the U.S. Gulf Coast*, Consultant Report. J. Laughlin, March 14,2002.
[11] California Energy Commission, *Marine Product Tanker Fundamentals*, Consultant Report, Publication 600-02-007
[12] California Energy Commission, *Forecasts of California Transportation Energy Demand, 2003-2023,* Draft Staff Report, Publication #600-03-009SR
[13] Holly Kranzmann, Shell Oil Product U.S., Presentation at California Energy Commission, Integrated Energy Policy Report -Transportation Fuels Workshop, July 11, 2003, Docket #02-IEP-01
[14] California Energy Commission, *Forecasts of California Transportation Energy Demand, 2003-2023,* Draft Staff Report, Publication #600-03-009SR
[15] Energy Information Administration, U.S. Department of Energy Publication: *The Transition to Ultra-Low-Sulfur Diesel Fuel: Effects on Prices and Supply*
[16] Joseph Leto, Energy Analysts International, Presentation: "U.S. West Coast Petroleum Supply, Logistics and Economic Outlook" at California Energy Commission, Integrated Energy Policy Report -Transportation Fuels Workshop, July 11, 2003, Docket #02-IEP-01
[17] Donald Gautier, Ph.D., United States Geological Survey, Presentation: USGS World Petroleum Resource Assessment at California Energy Commission, Integrated Energy Policy Report -World Oil Supply Workshop, April 28, 2003, Docket #02-IEP-01
[18] Ibid

[19] Source: Oil Price Information Service
[20] California Attorney General's Office, Task Force Study Results: *Report on Gasoline Pricing in California*, May 2000
[21] California Energy Commission, *Government Use of the California Gasoline Forward Market*, Contractor Report P600-03007D, April, 2003.
[22] California Energy Commission, *California Marine Petroleum Infrastructure*, Contractor Report, P300-03-008D, April, 2003.
[23] Tony Hoff, ST Services, Presentations: "Strategic Fuel Reserve: The Right Strategy?," at California Energy Commission Strategic Fuel Reserve Workshop, April 25, 2003
[24] California Energy Commission, *California Strategic Fuels Reserve,* Revised Contractor Report, Page 82. Publication # P600-02-017D, July, 2002
[25] California Energy Commission, *Permit Streamlining for Petroleum Product Storage*, Contractor Report P300-03-006D, April, 2003.
[26] Joseph Leto,, Energy Analysts International, Presentation: "U.S. West Coast Petroleum Supply, Logistics and Economic Outlook" at California Energy Commission, Integrated Energy Policy Report -Transportation Fuels Workshop, July 11, 2003, Docket #02-IEP-01
[27] U.S Environmental Protection Agency, *Automobile Technology and Fuel Economy Trends 1975-2003*, April 2003
[28] California Energy Commission, *California State Fuel-Efficient Tire Program*, Consultant Report, Volume II, January 2003
[29] California Department of Motor Vehicles data, 2001
[30] California Energy Commission*, Reducing California's Petroleum Dependence*, Attachment B, Joint Agency Draft Report, July 2003, P600-03-005D
[31] Ibid
[32] Mark Rechtin,"Toyota Raises Hybrid Standard With Prius," *Automotive News*, April 21, 2003
[33] California Energy Commission*, Reducing California's Petroleum Dependence*, Joint Agency Draft Report, July 2003, P600-03-005D
[34] National Biodiesel Board; <www.biodiesel.org/resources/faqs/default.shtm>; June 2003
[35] Scott Hughes, National Biodiesel Board, California Energy Commission Memo, April 2003
[36] California Energy Commission, TIAX, LLC; *California Clean Fuels Market Assessment* 2003, Draft Consultant Report
[37] Ibid
[38] Ibid
[39] Ibid
[40] Ibid
[41] California Energy Commission, *Reducing California's Petroleum Dependence,* Appendix A, Joint Agency Draft Report, July 2003, P600-03-005D

[42] Ibid
[43] Ibid
[44] California Energy Commission, *Reducing California's Petroleum Dependence,* Appendix D, Joint Agency Draft Report, July 2003, P600-03-005D
[45] California Energy Commission, *Reducing California's Petroleum Dependency*,

Appendix A, Joint Agency Draft Report, July 2003, P600-03-005D

[46] California Energy Commission, *Reducing California's Petroleum Dependency*, Appendix D, Joint Agency Draft Report, July 2003, P600-03-005D